M-Max Series
adjustable frequency drive

Effective November 2009

User Manual

Powering Business Worldwide

Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit the device.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (IL04020001E) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the extra-low voltage of the 24 V supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed and with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).
- Depending on their degree of protection, adjustable frequency drives may contain live bright metal parts, moving or rotating components or hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or adjustable frequency drive may cause the failure of the device and may lead to serious injury or damage.
- The applicable national accident prevention and safety regulations apply to all work carried on live adjustable frequency drives.
- The electrical installation must be carried out in accordance with the relevant regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing adjustable frequency drives must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the adjustable frequency drives using the operating software are permitted.

- All covers and doors must be kept closed during operation.
- To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the drive (increased motor speed or sudden standstill of motor). These measures include:
  - Other independent devices for monitoring safety-related variables (speed, travel, end positions etc.).
  - Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).
  - Never touch live parts or cable connections of the adjustable frequency drive after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be live after disconnection. Fit appropriate warning signs.

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About This Manual

This manual provides a description of the adjustable frequency drives of the M-Max™ Series. It provides special information required for project planning, installation and for the operation of the MMX adjustable frequency drive. All information applies to the specified hardware and software versions.

Please read the manual thoroughly before you install and operate the adjustable frequency drive.

We assume that you have a good knowledge of engineering fundamentals and that you are familiar with handling electrical systems and machines, as well as with reading technical drawings.

Writing Conventions

The symbols used in this manual have the following meanings:

▶ Indicates instructions to be followed

→ Indicates useful tips and additional information.

Caution!
Warns about the possibility of minor property damage.

Warning!
Warns about the possibility of serious property damage and minor injuries.

Danger!
Warns about the possibility of major property damage and serious injuries or death.

→ In order to make it easier to follow the manual, the name of the current chapter is shown in the header of the left-hand page and the name of the current section is shown in the header of the right-hand page. This does not apply to pages at the start of a chapter or to empty pages at the end of a chapter.

→ In order to make it easier to understand some of the figures included in this manual, the housing of the adjustable frequency drive, as well as other safety-relevant parts, have been left out. However, it is important to note that the adjustable frequency drive must always be operated with its housing placed properly, as well as with all required safety-relevant parts.

→ Please follow the installation instructions in the IL04020001E installation instructions document.

→ This manual was created in an electronic format. You can also order a hard copy version of it.

→ All the specifications in this manual refer to the hardware and software versions documented in it.

→ More information on the series described here can be found on the Internet under:

www.eaton.com/M-Max

Abbreviations and Symbols

The abbreviations and symbols used in this manual have the following meanings:

EMC	Electromagnetic compatibility
FS	Frame Size
GND	Ground, 0-V-Potential
IGBT	Insulated-gate bipolar transistor
PDS	Power Drives System
PES	EMC connection to PE for shielded lines
PNU	Parameter number
UL	Underwriters Laboratories

M-Max adjustable frequency drives are divided into three voltage categories:

- 115 V (MMX11)
- 200 V (MMX12…, MMX32…)
- 400 V (MMX34…)

These voltage categories are based on standardized nominal line voltage values (IEC 60038, VDE 017-1) at the electric utility's (EVU) supply terminal:

- 115 V → 115 V ±10 % (50/60 Hz)
- 200 V → 230 V ±10 % (50/60 Hz)
- 400 V → 400 V ±10 % (50/60 Hz)

The wide tolerance range of adjustable frequency drive M-Max takes into account a permissible voltage drop of an additional 4 % (U_{LN} - 14 %) in load networks, while, in the 400 V category, it takes into account the North American line voltage of 480 V +10 % (60 Hz).

The permissible connection voltages for the M-Max series are listed in the Technical Specifications section in the appendix.

Units

Every physical dimension included in this manual uses international metric system units, otherwise known as SI (Système international d'unités) units. For the purpose of the equipment's UL certification, some of these dimensions are accompanied by their equivalents in imperial units.

Table 1: Unit conversion examples

Designation	US-American value	SI value	Conversion value	US-American designation
Length	1 inch (")	25.4 mm	0.0394	inch
Power	1 HP = 1.014 PS	0.7457 kW	1.341	horsepower
Torque	1 lbf in	0.113 Nm	8.851	pound-force inches
Temperature	1 °F (T_F)	-17.222 °C (T_C)	$T_F = T_C \times 9/5 + 32$	Fahrenheit
Speed	1 rpm	1 rpm	1	revolutions per minute
Weight	1 lb	0.4536 kg	2.205	pound

1 M-Max Series

System overview

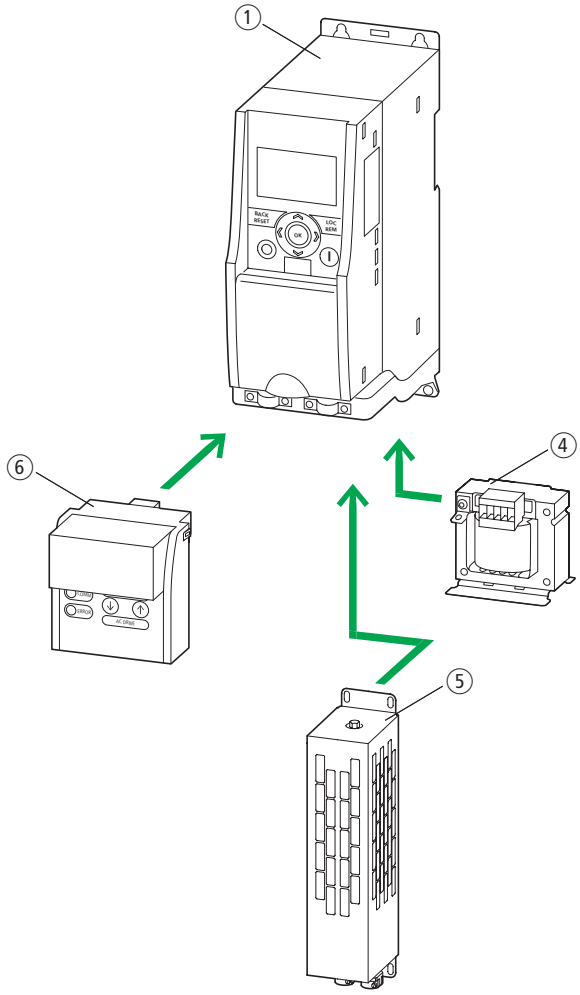


Figure 1: System overview

① Adjustable frequency drives MMX-…
② Line reactor, Load reactor, Sinusoidal filter
③ Braking resistor
④ Communication module MMX-COM-PC

Checking the Delivery

→ Before opening the packaging go over the ratings plate on the packaging and check for whether the delivered adjustable frequency drive is the same type as the one you ordered.

M-Max adjustable frequency drives have been carefully packaged and prepared for delivery. These devices should only be shipped in their original packaging with suitable transportation materials. Please take note of the labels and instructions on the packaging, as well as of those meant for the unpacked device.

Open the packaging with adequate tools and inspect the contents immediately after receipt in order to ensure that they are complete and undamaged.

The packaging must contain the following parts:

- an M-Max adjustable frequency drive,
- an accessory kit for EMC-suitable installation
- installation instructions IL04020001E
- a data carrier (CD-ROM) with documentation and parameter configuration software

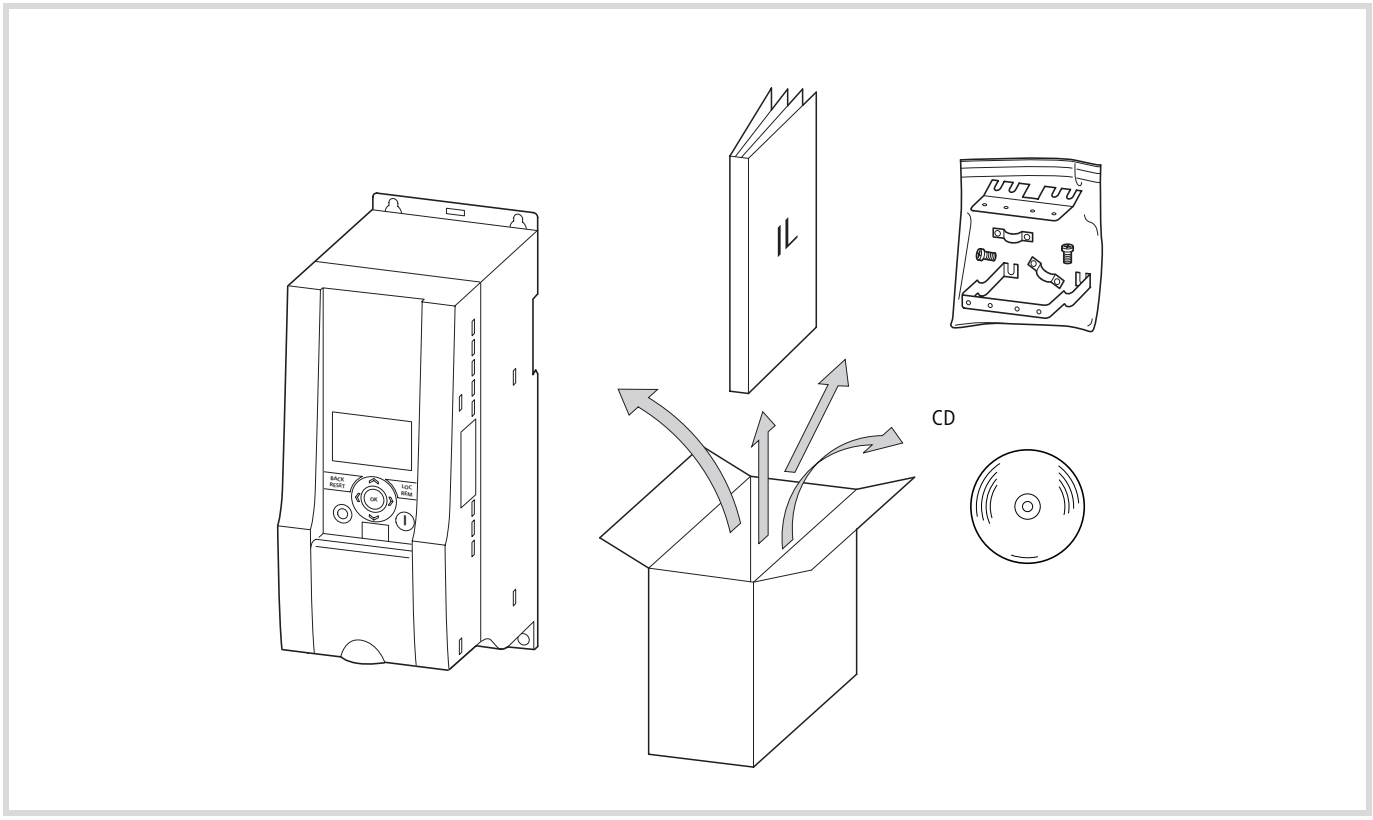


Figure 2: Scope of supply

Rating and Rating Plate

The rating for M-Max adjustable frequency drives is indicated on the corresponding rating plate, located on the side of the device.

Figure 3: Rating plate on side of device

Figure 4: M-Max adjustable frequency drive rating plate (example)

Label	Meaning
MMX34AA3D3F0-0	Part no.: MMX = M-Max series adjustable frequency drive 3 = Three-phase power connection 4 = 400 V voltage category AA = Instance (Software version A and alphanumerical display) 3D3 = 3.3 A rated operational current (3-decimal-3) F = Integrated radio interference suppression filter 0 = IP20 protection type 0 = No integrated optional assembly
Input	Power connection rating: Three-phase AC voltage (U_e 3~ AC), 380 - 480 V voltage, 50/60 Hz frequency, input phase current (4.0 A)
Output	Load side (motor) rating: Three-phase AC voltage (0 - U_e), output phase current (3.3 A), output frequency (0 - 320 Hz)
Motor	Assigned motor rating 1.1 kW at 400 V/1.5 HP at 460 V for a four-pole internally-cooled or surface-cooled three-phase asynchronous motor (1500 rpm at 50 Hz/ 1800 rpm at 60 Hz)
S/N	Serial number
	adjustable frequency drive is an electrical apparatus. Read the manual (in this case IL04020001E) before making any electrical connections and commissioning.
Max amb. 50 °C	The maximum ambient temperature during operation may not exceed +50 °C.

The inscription of the nameplate has the following meaning (example):

Key to part numbers

The type designation code and the part no. of the M-Max adjustable frequency drive series are in the following order:

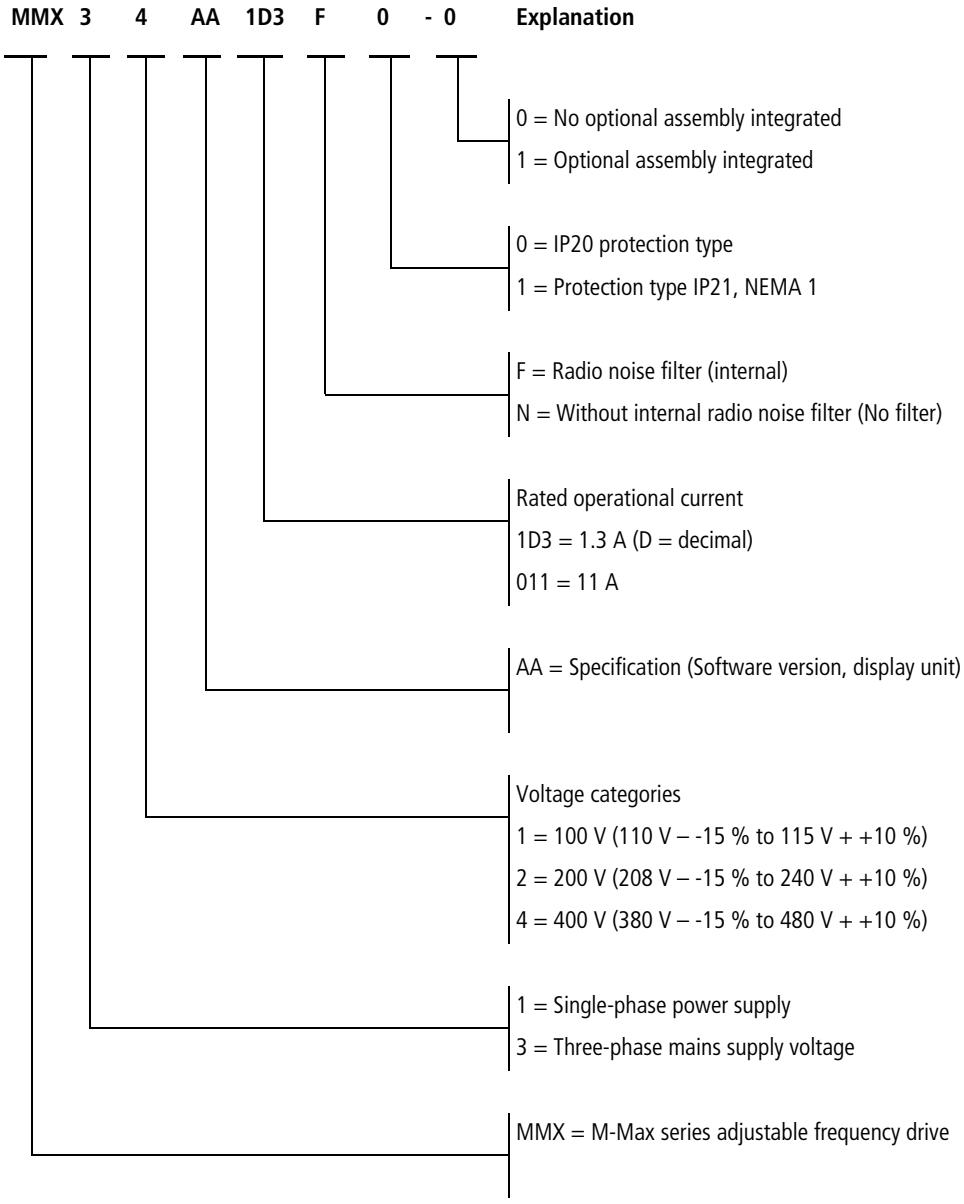

MMX 3 4 AA 1D3 F 0 - 0 Explanation
0 = No optional assembly integrated
1 = Optional assembly integrated
0 = IP20 protection type
1 = Protection type IP21, NEMA 1
F = Radio noise filter (internal)
N = Without internal radio noise filter (No filter)
Rated operational current
1D3 = 1.3 A (D = decimal)
011 = 11 A
AA = Specification (Software version, display unit)
Voltage categories
1 = 100 V (110 V – -15 % to 115 V + +10 %)
2 = 200 V (208 V – -15 % to 240 V + +10 %)
4 = 400 V (380 V – -15 % to 480 V + +10 %)
1 = Single-phase power supply
3 = Three-phase mains supply voltage
MMX = M-Max series adjustable frequency drive

Figure 5: Type designation code of the M-Max adjustable frequency drive

Examples

Label	Meaning
MMX12AA1D7F0-0	M-Max series adjustable frequency drive: 1 = Single-phase mains connection 2 = Rated voltage 230 V AA = Software version 1D7 = 1.7 A (rated current) F = Integrated radio noise filter 0 = IP20 protection type -0 = No integrated optional assembly
MMX32AA2D4F0-0	M-Max series adjustable frequency drive: 3 = Three-phase power connection 2 = Rated voltage 230 V AA = Software version 2D4 = 2.4 A (rated current) F = Integrated radio noise filter 0 = IP20 protection type -0 = No integrated optional assembly
MMX34AA012F0-0	M-Max series adjustable frequency drive: 3 = Three-phase power connection 4 = Rated voltage 400 V AA = Software version 012 = 12 A (rated current) F = Integrated radio noise filter 0 = IP20 protection type -0 = No integrated optional assembly

General rated operational data

Technical data	Unit	Value
General		
Standards and regulations		EMC: IEC/EN61800-3, Safety: IEC/EN61800-5, UL508C
Certifications and manufacturer's declarations on conformity		EMC: CE, CB, c-Tick Safety: CE, CB, UL, cUL
Production quality		RoHS, ISO 9001
Climatic proofing		< 95 %, average relative humidity, non-condensing (EN50178)
Air quality		
Chemical vapors		IEC721-3-3: Device in operation, Class 3C2
Mechanical particles		IEC721-3-3: Device in operation, Class 3S2
Ambient temperature		
Operation	°C/°F	-10 – +50[1)] / +14 – +122[1)]
Storage	°C/°F	-40 – +70 / -40 – +158
Installation altitude	H	0 – 1000 m above sea level, over 1000 m with 1 % power reduction per 100 m, maximum 2000 m with corner grounding, maximun 4700 m with non-corner grounding, max. +50 °C ambient temperature
Mounting position		Vertical (± 90 degrees lateral rotation)
Protection type		IP 20
Protection against direct contact		BGV A3 (VBG4, finger and back-of-hand safe)
Over-voltage category/degree of pollution		-
Mechanical shock resistance		IEC 68-2-27 Storage and transport: 15 g, 11 ms (in the packaging) UPS drop test (for applicable UPS weights)
Vibration		EN 60068-2-6 3 – 150 Hz, oscillation amplitude 1 mm (Peak) at 3 – 15.8 Hz, maximum acceleration amplitude 1 g at 15.8 – 150 Hz
Emitted interference with internal EMC filter (maximum motor cable length)		C2: Class A in 1st environment (residential area with commercial utilization) C3: Class A in 2nd environment (Industrial)
MMX11, MMX12, MMX32, MMX34		C2 (5 m), C3 (30 m)
Power section		
Rated operational voltage		at 50/60 Hz
MMX11	U_e	1 AC 115V
MMX12	U_e	1 AC 230 V (177 – 264 ±0 %)
MMX32	U_e	3 AC 230 V (177 – 264 ±0 %)
MMX34	U_e	3 AC 400 V (323 – 528 ±0 %)
Mains network configuration (AC power supply network)		Center-point grounded star network (TN-S network) Phase grounded AC networks are not permitted.
Mains switch-on frequency		Maximum one time per minute
Mains current	THD	>120 %
Short-circuit current		max. < 50 kA
Mains frequency	f_{LN}	50/60 Hz (45 – 66 Hz ±0 %)
Pulse frequency (switching frequency of the inverter)	f_{PWM}	1 kHz – 16 kHz (WE: 6 kHz)[1)]
Operating mode		V/Hz-characteristic curve control (WE), sensorless vector control (open loop)
Output voltage	U_2	3 AC U_e

Technical data	Unit	Value
Output frequency	f_2	0 – 320 Hz (WE: 0 – 50 Hz)
Frequency resolution (setpoint value)	Hz	0.01
Rated current	I_e	100 % continuous current at maximum +50 °C ambient temperature
Overload current		150 % for 60 s every 600 s
Starting current		200 % for 2 s every 20 s
Braking torque		Maximum 30 % M_N for all sizes up to maximum 100 % M_N only as of size MMX34…4D3.. with external braking resistance
Control section		
Control voltage (output)	V DC	24, max. 50 mA
Reference voltage (output)	V DC	10, max. 10 mA
Input, digital, parameter definable		6 x, max. +30 V DC, $R_i > 12$ kΩ
Permitted residual ripple with external control voltage (+24 V)		max. 5 % $\Delta U_a/U_a$
Input, analog, parameter definable		1 x 0 – +10 VDC, $R_i > 200$ kΩ 1 x 0 (4) – 20 mA, $R_B \sim 200$ Ω
Resolution	Bit	10
Output, analog, parameter definable		1 x 0 (4) – 20 mA, $R_B < 500$ Ω
Resolution	Bit	10
Output, digital, parameter definable		1 x transistor, open collector, 48 V DC, maximum 50 mA
Output relay, parameter definable		1 x N/O 250 V AC, maximum 2 A/250 V DC, maximum 0.4 A
Output relay, parameter definable		1 x C/O 250 V AC, maximum 2 A/250 V DC, maximum 0.4 A
Serial interface		RS485/Modbus RTU

1) With MMX34AA014F0-0, the maximum permitted ambient temperature is limited to +40 °C and the maximum pulse frequency (f_{PWM}) to 4 kHz.

Technical data

Part no.	Rated current	Overload current (150 %)	Assigned motor rating				Installation size
	I_e	I_{150}	P (230 V, 50 Hz)		P (230 V, 60 Hz)		
	[A]	[A]	[kW]	[A] 1)	[HP]	[A] 1)	
Power connection voltage: 1 AC 230 V, 50/60 Hz (177 - 264 V ±0 %, 45 - 66 Hz ±0 %)							
MMX12AA1D7F0-0	1.7	2.6	0.25	1.4	- 2) 1/3	- 2)	FS1
MMX12AA2D4F0-0	2.4	3.6	0.37	2	1/2	2.2	FS1
MMX12AA2D8F0-0	2.8	4.2	0.55	2.7	3/4	2.2	FS1
MMX12AA3D7F0-0	3.7	5.6	0.75	3.2	1	3.2	FS1
MMX12AA4D8F0-0	4.8	7.2	1.1	4.6	1 1/2	4.2	FS2
MMX12AA7D0F0-0	7	10.5	1.5	6.3	2	6.8	FS2
MMX12AA9D6F0-0	9.6	14.4	2.2	8.7	3	9.6	FS3
Power connection voltage: 3AC 230 V, 50/60 Hz (177 – 264 V ±0 %, 45 – 66 Hz ±0 %)							
MMX32AA1D7F0-0	1.7	2.6	0.25	1.4	1/3	-	FS1
MMX32AA2D4F0-0	2.4	3.6	0.37	2	1/2	2.2	FS1
MMX32AA2D8F0-0	2.8	4.2	0.55	2.7	3/4	2.2	FS1
MMX32AA3D7F0-0	3.7	5.6	0.75	3.2	1	3.2	FS1
MMX32AA4D8F0-0	4.8	7.2	1.1	4.6	1 1/2	4.2	FS2
MMX32AA7D0F0-0	7	10.5	1.5	6.3	2	6.8	FS2
MMX32AA011F0-0	9.6	14.4	2.2	8.7	3	9.6	FS3

1) Rated motor currents for normal four-pole internally-cooled and surface-cooled three-phase asynchronous motors (1500 rpm at 50 Hz, 1800 rpm at 60 Hz)

2) No standardized motor output allocated

Part no.	Rated current	Overload current (150 %)	Assigned motor rating				Installation size
	I_e	I_{150}	P (400 V, 50 Hz)		P (460 V, 60 Hz)		
	[A]	[A]	[kW]	[A]1)	[HP]	[A]1)	
Power connection voltage: 3AC 400 V, 50/60 Hz (323 – 528 V ±0 %, 45 – 66 Hz ±0 %)							
MMX34AA1D3F0-0	1.3	2	0.37	1.1	1/2	1.1	FS1
MMX34AA1D9F0-0	1.9	2.9	0.55	1.5	3/4	1.6	FS1
MMX34AA2D4F0-0	2.4	3.6	0.75	1.9	1	2.1	FS1
MMX34AA3D3F0-0	3.3	5	1.1	2.6	1-1/2	3	FS1
MMX34AA4D3F0-0	4.3	6.5	1.5	3.6	2	3.4	FS2
MMX34AA5D6F0-0	5.6	8.4	2.2	5	3	4.8	FS2
MMX34AA7D6F0-0	7.6	11.4	3	6.6	4	7.6	FS3
MMX34AA9D0F0-0	9	13.5	4	8.5	5	7.6	FS3
MMX34AA012F0-0	12	18	5.5	11.3	7-1/2	11	FS3
MMX34AA014F0-0	14	21	7.5[2)]	(15.2)[3)]	10[2)]	14	FS3
Power connection voltage: 1AC 115V, 50/60 Hz (93 – 132 V ±0 %, 45 – 66 Hz ±0 %)							
MMX11AA1D7N0-0	1.7	2.6	0.19	1.4	1/4	1.4	FS2
MMX11AA2D4N0-0	2.4	3.6	0.37	2	1/2	2.2	FS2
MMX11AA2D8N0-0	2.8	4.2	0.55	2.7	3/4	2.7	FS2
MMX11AA3D7N0-0	3.7	5.6	0.75	3.2	1	3.2	FS2
MMX11AA4D8N0-0	4.8	7.2	1.10	4.6	1 1/2	4.2	FS3

1) Rated motor currents for normal four-pole internally-cooled and surface-cooled three-phase asynchronous motors (1500 rpm at 50 Hz, 1800 rpm at 60 Hz)

2) Allocated motor output at a maximum ambient temperature of +40 °C and a maximum pulse frequency of 4 kHz

3) Operation with reduced load torque (about -10 % M_N)

M-Max Designation

The following drawing shows an M-Max device.

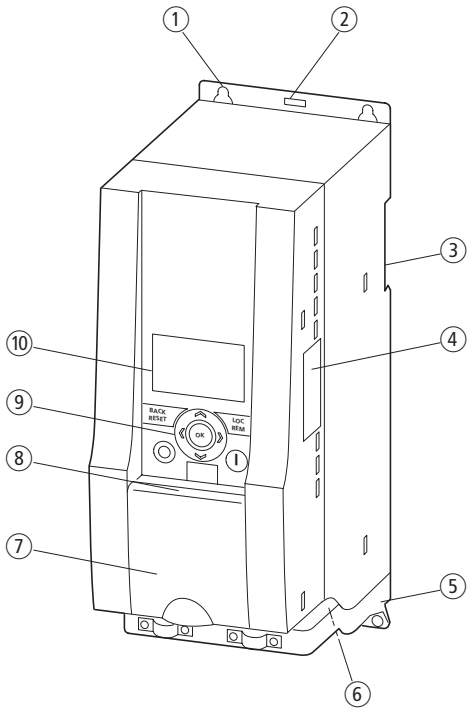


Figure 6: Designations on M-Max

① Mounting holes (screw fastening)
② Release (removal from mounting rail)
③ Recess for mounting on mounting rail (DIN EN 50022-35)
④ EMC installation accessories
⑤ Power section terminals
⑥ Cover for control signal terminals
⑦ Interface for MMX-COM-PC
⑧ Control unit
⑨ Display unit (LCD)

Features

The adjustable frequency drives of the M-Max series converts voltage and frequencies from an existing AC network into DC voltage and from this DC voltage it generates a three phase AC voltage with adjustable voltage and frequency values. This adjustable output voltage enables a smooth variable speed adjustment for AC asynchronous motors.

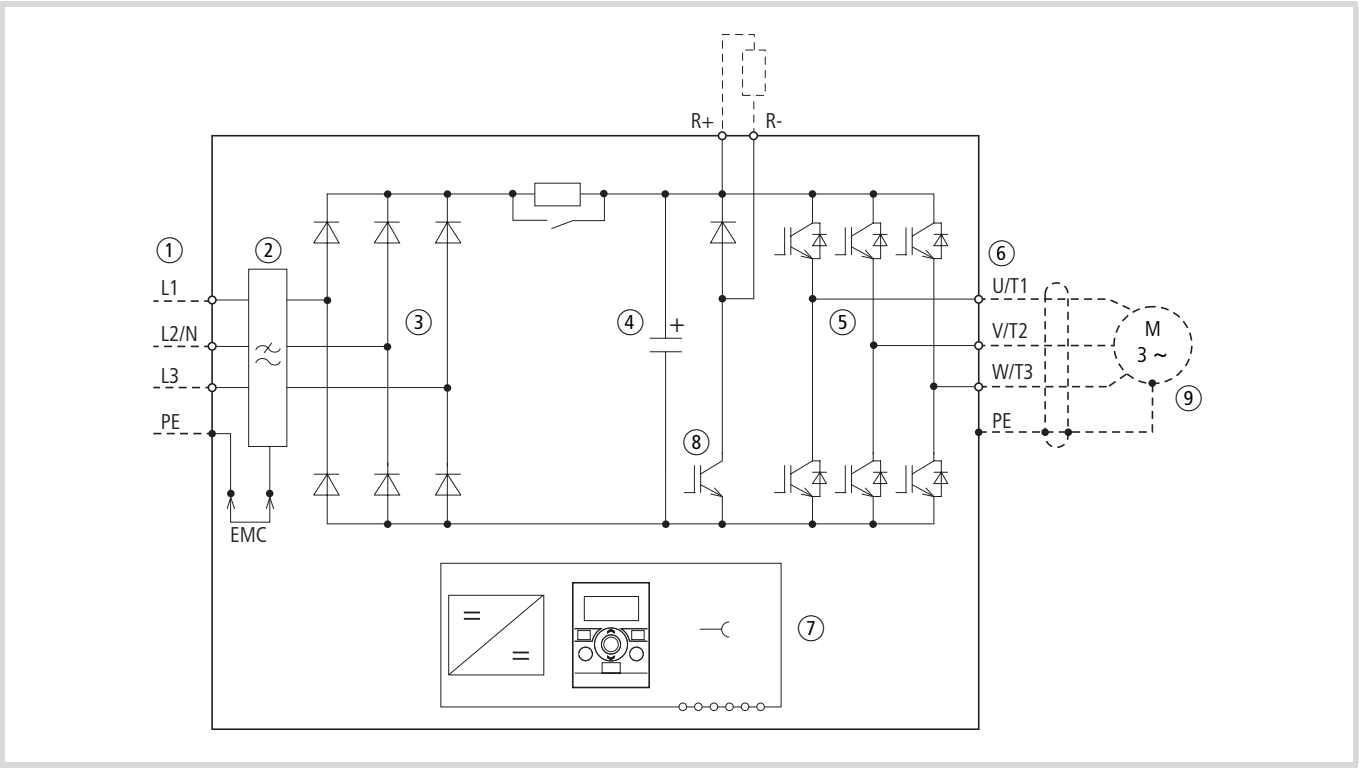


Figure 7: Block diagram, subassemblies of the adjustable frequency drive M-Max

① Supply L1, L2/N, L3, PE, mains connection voltage U_e at 50/60 Hz:
MMX11: 100-V class, single-phase mains connection (1 AC 115 V)
MMX12: 200-V class, single-phase mains connection (1 AC 230 V)
MMX32: 200-V class, three-phase mains connection (3 AC 230 V)
MMX34: 400-V class, three-phase mains connection (3 AC 460 V)

② Internal radio noise filter, category C2 and C3, conforming with IEC/EN61800-3. EMC-connection of the internal radio noise filter with PE

③ Rectifier bridge, single phase (MMX1…) or three-phase (MMX3…), converts the AC voltage of the electrical network into DC voltage.

④ DC voltage link circuit with load resistance, capacitor and switched power supply
DC link voltage $U_{DC} \sim 2 \times U_e$ (mains supply voltage)

⑤ Inverter. The inverter equipped with IGBT converts the DC voltage of the link circuit (U_{DC}) into a variable three-phase AC voltage (U_2) with variable frequency (f_2). Sinusoidally evaluated pulse width modulation (PWM) with sensorless vector control, switching to V/Hz-controller

⑥ Motor connection U/T1, V/T2, W/T3 with output voltage U_2 (0 to 100 % U_e) and output frequency f_2 (0 to 320 Hz)
Output current (I_2):
MMX11: 1.7 A – 4.8 A
MMX12: 1.7 A – 9.6 A
MMX32: 1.7 A – 9.6 A
MMX34: 1.3 A – 14 A
100 % at an ambient temperature of +50 °C with an overload capacity of 150 % for 60 s, every 600 s and a starting current of 200 % for 2 s every 20 s

⑦ Operating unit with LCD display, control voltage, control signal terminals and interface

⑧ Braking transistor, connections R+ and R- for external braking resistance (only with MMX34)

⑨ Three-phase asynchronous motor
Variable speed control of three-phase asynchronous motors for assigned motor outputs (P_2):
MMX12: 0.19 – 1.1 kW (230 V, 50 Hz) / 0.25 – 1.5HP (230 V, 60 Hz)
MMX32: 0.25 – 2.2 kW (230 V, 50 Hz) / 0.25 – 3 HP (230 V, 60 Hz)
MMX34: 0.37 – 7.5 kW (400 V, 50 Hz) / 0.5 – 10 HP (460 V, 60 Hz)
MMX11: 0.25 – 1.5 kW (115 V, 60 Hz)

Selection criteria

Selecting the adjustable frequency drive ③ is done based on the supply voltage U_{LN} of the supply network ① and the rated operational current of the assigned motor ②. In this case, the switching operation (Δ / Y) of the motor must be selected for the supply voltage ①. The rated output current I_e of the adjustable frequency drive must be greater than or equal to the rated motor current.

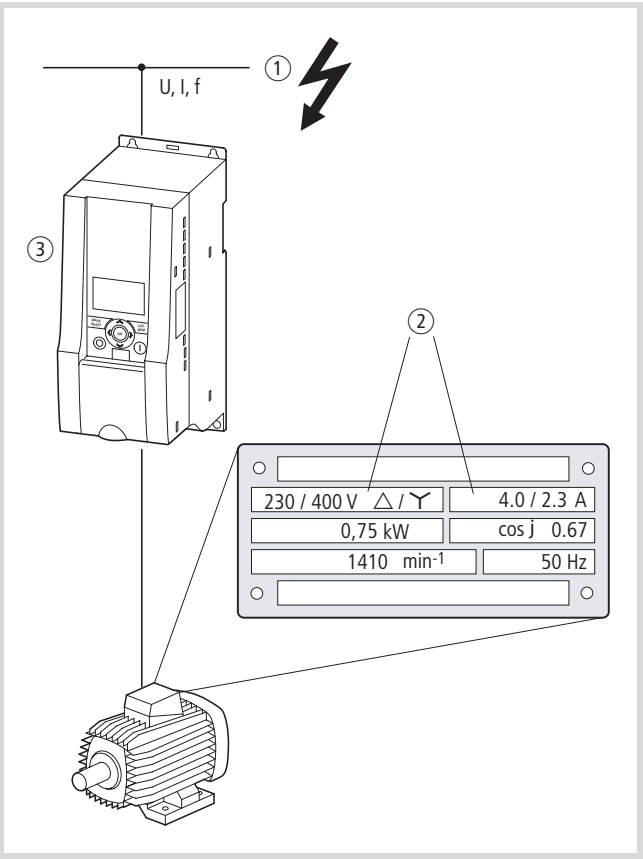


Figure 8: Selection criteria

When selecting the drive, the following criteria must be known:

- Type of motor (three-phase asynchronous motor)
- Mains voltage = rated operating voltage of the motor (e.g. 3 AC ~ 400 V),
- Rated motor current (guide value, dependent on the circuit type and the supply voltage)
- Load torque (quadratic, constant),
- Starting torque,
- Ambient temperature (rated value +40 °C).

→ When connecting multiple motors in parallel to the output of a adjustable frequency drive, the motor currents are added geometrically – separated by effective and idle current components. Calculate the size of the adjustable frequency drive large enough so that the total current can be supplied by the adjustable frequency drive. If necessary, for dampening and compensating the deviating current values, motor reactors or sinusoidal filters must be connected between the adjustable frequency drive and the motor.

The parallel connection of multiple motors in the output of the adjustable frequency drive is only permitted with V/Hz-characteristic curve control.

→ If you connect a motor to an operational adjustable frequency drive, the motor draws a multiple of its rated current. When you select a adjustable frequency drive, make sure that the starting current plus the sum of the currents of the running motors will not exceed the rated output current of the adjustable frequency drive.

Switching in the output of the adjustable frequency drive is only permitted with V/Hz-characteristic curve control.

Voltage class 100 V: 50/60 Hz ①
Mains supply voltage 100V - 15% - 120V + 10%

Motor rating ② (230 V, 50 Hz)		Motor rating ② (230 V, 60 Hz)		Part no. ③ (at U_{LN} = 3 AC)	Rated operational current of MMX
P	I_e	P	I_e		I_e
[kW]	[A]1)	[HP]	[A]1)		[A]
0.19	1.4	1/4	1.4	MMX11AA107N0-0	1.7
0.37	2	1/2	2.2	MMX11AA2D4N0-0	2.4
0.55	2.7	3/4	2.7	MMX11AA2D8N0-0	2.8
0.75	3.2	1	3.2	MMX11AA3D7N0-0	3.7
1.1	4.6	1 1/2	4.2	MMX11AA4D8N0-0	4.8

1) Rated motor currents for normal four-pole, internally and externally ventilated three-phase asynchronous motors with 1500 rpm (at 50Hz) and 1800 rpm (at 60Hz)

Voltage class 230 V: 50/60 Hz ①
Mains supply voltage 208 V -15 % – 240 V + +10 %

Motor rating ② (230 V, 50 Hz)		Motor rating ② (230 V, 60 Hz)		Part no. ③ (at U_{LN} = 1 AC)	Part no. ③ (at U_{LN} = 3 AC)	Rated operational current of MMX
P	I_e	P	I_e			I_e
[kW]	[A]1)	[HP]	[A]1)			[A]
0.25	1.4	-	-	MMX12AA1D7F0-0	MMX32AA1D7F0-0	1.7
0.37	2	1/2	2.2	MMX12AA2D4F0-0	MMX32AA2D4F0-0	2.4
0.55	2.7	1/2	2.2	MMX12AA2D8F0-0	MMX32AA2D8F0-0	2.8
0.75	3.2	3/4	3.2	MMX12AA3D7F0-0	MMX32AA3D7F0-0	3.7
1.1	4.6	1	4.2	MMX12AA4D8F0-0	MMX32AA4D8F0-0	4.8
1.5	6.3	2	6.8	MMX12AA7D0F0-0	MMX32AA7D0F0-0	7
2.2	8.7	3	9.6	MMX12AA9D6F0-0	MMX32AA011F0-0	9.6

1) Rated motor currents for normal four-pole, internally and externally ventilated three-phase asynchronous motors with 1500 rpm (at 50 Hz) and 1800 rpm (at 60 Hz)

Voltage class 400 V: 50/60 Hz ①
Mains supply voltage 380 V -15 % – 480 V + +10 %

Motor rating ② (400 V, 50 Hz)		Motor rating ② (460 V, 60 Hz)		Part no. ③ (at U_{LN} = 3 AC)	Rated operational current of MMX
P	I_e	P	I_e		I_e
[kW]	[A]1)	[HP]	[A]1)		[A]
0.37	1.1	1/2	1.1	MMX34AA1D3F0-0	1.3
0.55	1.5	3/4	1.6	MMX34AA1D9F0-0	1.9
0.75	1.9	1	2.1	MMX34AA2D4F0-0	2.4
1.1	2.6	1-1/2	3	MMX34AA3D3F0-0	3.3
1.5	3.6	2	3.4	MMX34AA4D3F0-0	4.3
2.2	5	3	4.8	MMX34AA5D6F0-0	5.6
3	6.6	5	7.6	MMX34AA7D6F0-0	7.6
4	8.5	5	7.6	MMX34AA9D0F0-0	9
5.5	11.3	7-1/2	11	MMX34AA012F0-0	12
7.5[2)]	(15.2)[3)]	10	14	MMX34AA014F0-0	14

1) Rated motor currents for normal four-pole, internally and externally ventilated three-phase asynchronous motors with 1500 rpm (at 50 Hz) and 1800 rpm (at 60 Hz)
2) Assigned motor output at a maximum ambient temperature of +40 °C and a maximum pulse frequency of 4 kHz
3) Operation with reduced load torque (about-10%)

Proper use

The M-Max adjustable frequency drives are not domestic appliances.
They are designed only for industrial use as system components.

The M-Max adjustable frequency drives are electrical apparatus for controlling variable speed drives with three-phase motors. They are designed for installation in machines or for use in combination with other components within a machine or system.

After installation in a machine, the adjustable frequency drives must not be taken into operation until the associated machine has been confirmed to comply with the safety requirements of Machinery Safety Directive (MSD) 89/392/EEC (meets the requirements of EN 60204). The user of the equipment is responsible for ensuring that the machine use complies with the relevant EU Directives.

The CE markings on the M-Max adjustable frequency drive confirm that, when used in a typical drive configuration, the apparatus complies with the European Low Voltage Directive (LVD) and the EMC Directives (Directive 73/23/EEC, as amended by 93/68/EEC and Directive 89/336/EEC, as amended by 93/68/EEC).

In the described system configurations, M-Max adjustable frequency drives are suitable for use in public and non-public networks.

A connection to IT networks (networks without reference to earth potential) is permissible only to a limited extent, since the device's built-in filter capacitors connect the network with the earth potential (enclosure). On earth free networks, this can lead to dangerous situations or damage to the device (isolation monitoring required).

→ To the output of the adjustable frequency drive (terminals U, V, W) you must not:

- connect a voltage or capacitive loads (e.g. phase compensation capacitors),
- connect multiple adjustable frequency drives in parallel,
- make a direct connection to the input (bypass).

Observe the technical data and connection requirements. For additional information, refer to the equipment nameplate or label at the adjustable frequency drive and the documentation.

Any other usage constitutes improper use.

Maintenance and inspection

M-Max adjustable frequency drives are maintenance-free if the general rated operational data is observed (see section "Rating and Rating Plate", page 12) and with the consideration of the special technical data (see section "Special technical data" in the appendix).

There are no plans for replacing or repairing individual components of M-Max adjustable frequency drives.

If the M-Max adjustable frequency drive is damaged by external influences, repair is not possible. Dispose of the device in accordance with the respectively applicable environmental laws and provisions for the disposal of electrical or electronic devices.

Service and warranty

In the unlikely event that you have a problem with your Eaton M-Max adjustable frequency drive, please contact your local sales office.

When you call, have the following information ready:

- the exact adjustable frequency drive part no. (see nameplate),
- the date of purchase,
- a detailed description of the problem which has occurred with the adjustable frequency drive.

If some of the information printed on the nameplate is not legible, please state only the information which is clearly legible.

Information concerning the guarantee can be found in the Eaton General Terms and Conditions of Sale.

For technical assistance: 1-877-ETN-CARE (877-386-2273), Option 2.

2 Engineering

Introduction

This chapter describes the most important features in the energy circuit of a drive system (PDS = Power Drive System), which you should take into consideration in your project planning.

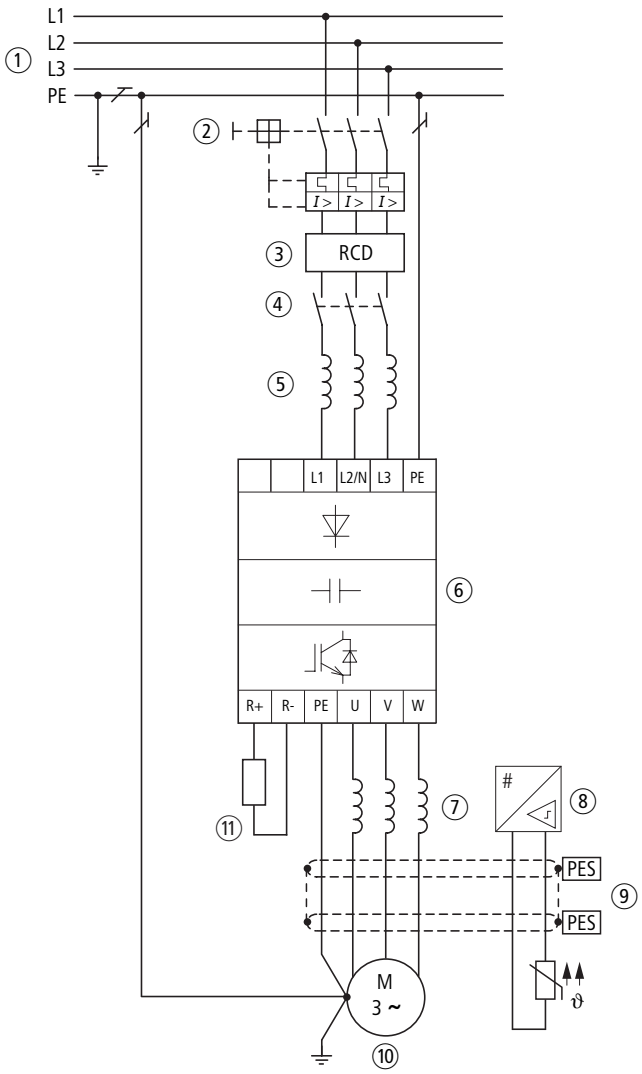


Figure 9: Drive system (PDS)

① Network configuration, mains voltage, mains frequency, interaction with p.f. correction systems
② Fuses and cable cross-sections, line protection
③ Protection of persons and domestic animals with residual-current protective devices
④ Mains contactor
⑤ Mains reactor, radio interference suppression filter, mains filters
⑥ adjustable frequency drive: mounting, installation; power connection; EMC measures; circuit examples
⑦ Motor reactor, du/dt filter, sine-wave filter
⑧ Motor protection; thermistor
⑨ Cable lengths, motor cables, shielding (EMC)
⑩ Motor and application, parallel operation of multiple motors on a adjustable frequency drive, bypass-circuit; DC braking
⑪ Braking resistance; dynamic braking

Electrical power network

Mains connection and configuration

The adjustable frequency drives of the M-Max series can be connected and operated with all control-point grounded AC power networks (see IEC 60364 for more information in this regard).

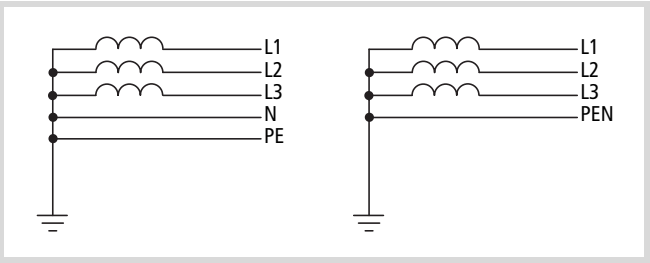


Figure 10: AC power networks with grounded center point (TN-/TT networks)

→ While planning the project, consider a symmetrical distribution to the three external conductors, if multiple adjustable frequency drives with single phase supplies are to be connected. The total current of all single phase consumers is not to cause an overload of the neutral conductor
(N-conductor).

The connection and operation of adjustable frequency drives to asymmetrically grounded TN networks (phase-grounded Delta network "Grounded Delta", USA) or non-grounded or high-resistance grounded (over 30 Ω) IT networks is only conditionally permissible.

If the adjustable frequency drives of the M-Max series are connected to an asymmetrically earthed TN network or an IT network (not earthed, insulated), the RFI filter must be switched off (unscrew the screw labeled with EMC, see section "Electrical Installation", page 37).
The required filter winding for electromagnetic compatibility (EMC) no longer exists in this case.

→ Measures for electromagnetic compatibility are mandatory in a drive system, to meet the legal requirements for EMC- and low-voltage regulations.

Good grounding measures are a prerequisite for the effective insert of further measures such as shielding or filters here. Without respective grounding measures, further steps are superfluous.

Mains voltage and frequency

The standardized mains voltages (IEC 60038, VDE017-1) for energy suppliers (EVU) guarantee the following conditions at the transition points:

- deviation from the rated value of voltage: maximum ±10 %
- deviation in voltage phase balance: maximum ±3 %
- deviation from rated value of the frequency: maximum ±4 %

The broad tolerance band of the M-Max adjustable frequency drive considers the rated value for
European as (EU: U_{LN} = 230 V/400 V, 50 Hz) and
American as (USA: U_{LN} = 120 V/240 V/480 V, 60 Hz) standard voltages:

- 100 V, 50 Hz (EU) and 120 V, 60 Hz (USA) at MMX11
- 200 V, 50 Hz (EU) and 240 V, 60 Hz (USA) at MMX12 and MMX32,
- 400 V, 50 Hz (EU) and 480 V, 60 Hz (USA) at MMX34…

For the bottom voltage value, the permitted voltage drop of 4 % in the consumer circuits is also taken into account, therefore a total of U_{LN} - 14 %.

- 100-V device class (MMX11):
  110V -15 % – 120 V +10 % (93 V -0 % – 132 V +0 %)
- 230-V device class (MMX12, MMX32):
  208 V -15 % – 240 V +10 % (177 V -0 % – 264 V +0 %)
- 400-V device class (MMX34):
  380 V -15 % – 480 V +120 % (323 V -0 % – 528 V +0 %)

The permitted frequency range is 50/60 Hz here (45 Hz -0 % – 66 Hz +0 %).

Voltage balance

Because of the uneven loading on the conductor and with the direct connection of greater power ratings, deviations from the ideal voltage form and unsymmetrical voltages can be caused in three-phase AC power networks. These asymmetric divergences in the mains voltage can lead to different loading of the diodes in mains rectifiers with three-phase supplied adjustable frequency drives and as a result, to an advance failure of this diode.

→ In the project planning for the connection of three-phase supplied adjustable frequency drives (MMX32, MMX34), consider only AC power networks that handle permitted asymmetric divergences in the mains voltage ≦ +3 %.

Should this condition not be met or if the symmetry is not known at the connection site, using an assigned mains reactor is recommended.

Total harmonic distortion (THD)

The THD (Total Harmonic Distortion) is a measurement for the occurring harmonic distortion of the sinusoidal oscillation (mains power side) input variables with the adjustable frequency drive. The entry is done as a percentage, with reference to the total value.

$$K = \sqrt{\frac{U_2^2 + U_3^2 + U_4^2 + \ldots + U_n^2}{U_1^2 + U_2^2 + U_3^2 + U_4^2 + \ldots + U_n^2}} \cdot 100\%$$

U_1 = fundamental component
THD k = 0.1 → K = 10 % ~ -20 dB (THD suppression)

$$THD = \frac{\sqrt{U_2^2 + U_3^2 + U_4^2 + \ldots + U_n^2}}{U_1}$$

THD (Total Harmonic Distortion)

With the adjustable frequency drives of the M-Max series, the permitted value for the total harmonic distortion THD >120 %.

Idle power compensation devices

Compensation on the power supply side is not required for the adjustable frequency drives of the M-Max series. From the AC power supply network they only take on very little reactive power of the fundamental harmonics (cos φ ~ 0.98).

→ In the AC power networks with non-choked idle current compensation devices, current deviations can enable parallel resonance and undefinable circumstances.

In the project planning for the connection of adjustable frequency drives to AC power networks with undefined circumstances, consider using mains reactors.

Mains reactors

A mains reactor (also called commutation inductors) increases the inductance of the power supply line. This extends the current flow period and dampens mains deviations.

On adjustable frequency drives, a mains reactor limits the mains feedback to permissible values. The harmonic current emissions that are fed back into the mains network ("mains feedback") are reduced. This reduces the mains-side apparent current to about 30 %.

Towards the adjustable frequency drive, the mains reactors dampen the interference from the supply network. This increases the withstand voltage of the adjustable frequency drive and lengthens the lifespan (diodes of the mains power rectifier, intermediate circuit capacitors).

→ For the operation of the M-Max adjustable frequency drive, the application of mains reactors is not necessary. We do recommend however that an upstream mains reactor is used since the network quality is not known in most cases.

While planning the project, consider that a mains reactor is only assigned to a single adjustable frequency drive for isolation. Using a large mains reactor for multiple small adjustable frequency drives should therefore be avoided if at all possible.

When using an adapting transformer (assigned to a single adjustable frequency drive), a mains reactor is not necessary.

Mains reactors are designed based on the mains-side input current (I_{LN}) of the adjustable frequency drive. Mains reactors and the assignment to M-Max adjustable frequency drives are explained in the appendix.

Safety and switching

Fuses and cable cross-sections

The fuses and wire cross-sections allocated for power-side connections depend on the rated mains current I_{LN} of the adjustable frequency drive (without mains reactor).

Caution!
Consider, when selecting the cable cross-section, the voltage drop with respective loading.
The consideration of other standards (e.g. VDE 0113 or VDE 0289) is the responsibility of the user.

The recommended fuses and their allocation to the adjustable frequency drives are listed in the appendix on page 117 ff.

The national and regional standards (for example VDE 0113, EN 60204) must be observed and the necessary approvals (for example UL) at the site of installation must be fulfilled.

When the device is operated in a UL-approved system, use only UL-approved fuses, fuse bases and cables.

The leakage currents to earth (to EN 50178) are greater than 3.5 mA. The connection terminals marked PE and the enclosure must be connected to the earth circuit.

The leakage currents for the individual performance variables are listed in the appendix on page 111 ff..

Caution!
The specified minimum PE conductor cross-sections (EN 50178, VDE 0160) must be maintained.

→ Choose the cross-section of the PE conductor in the motor lines at least as large as the cross-section of the phase lines (U, V, W).

Cables and fuses

The cross-sections of the cables and line protection fuses used must correspond with local standards.

For an installation in accordance with UL guidelines, the fuses and copper cable that are UL-approved and have a heat-resistance of +60/75 °C are to be used.

Use power cables with insulation according to the specified mains voltages for the permanent installation. A shielded cable is not required on the mains side.

On the motor side however, a complete (360°), low-impedance, shielded cable is necessary. The length of the motor cable depends on the radio interference class and is a maximum of 30 m with the M-Max.

Residual-current device

RCD (Residual Current Device): Residual current device, residual current circuit breaker (FI circuit breaker)

Residual current circuit breakers protect persons and animals from the existence (not the origination) of impermissibly high contact voltages. The prevent dangerous, in cases deadly injuries caused by electrical accidents and also serve as fire prevention.

Warning!
With adjustable frequency drives, only AC/DC sensitive residual current circuit breakers (RCD type B) are to be used (EN 50178, IEC 755).

Identification on the residual-current circuit-breakers	
universal current sensitive (RCD, type B)	

adjustable frequency drives work internally with rectified AC currents. If an error occurs, the DC currents can block an RCD circuit breaker of type A from triggering and therefore disable the protective functionality.

Caution!
Residual current circuit breakers (RCD) are only to be installed between the AC power supply network and the adjustable frequency drive.

Safety-relevant leakage currents can occur while handling and when operating the adjustable frequency drive, if the adjustable frequency drive is not grounded (because of a fault).

Leakage currents to ground are mainly caused by foreign capacities with adjustable frequency drives; between the motor phases and the shielding of the motor cable and via the Y-capacitors of the noise filter. The size of the leakage current is mainly dependent upon the:

- length of the motor cable,
- shielding of the motor cable,
- height of the pulse frequency (switching frequency of the inverter),
- design of the noise filter,
- Grounding measures at the site of the motor.

→ The leakage current to ground is greater than 3.5 mA with a adjustable frequency drive. Based on the requirements of EN 50178, an increased ground (PE) has to be connected. The cable cross-section must be at least 10 mm^2 or consist of two separately connected ground cables.

→ As long as you use residual current circuit breakers, they must be suitable for:

- the protection of installations with DC current component in case of fault scenario (RCD type B),
- high leakage currents (300 mA),
- brief discharges of pulse current spikes.

Mains contactor

The mains contactor enables an operational switching on and off of the supply voltage for the adjustable frequency drive and switching off in case of a fault.

The mains contactor is designed based on the mains-sie input current (I_{LN}) of the adjustable frequency drive and the consumption category AC-1 (IEC 60947). Mains contactors and the assignment to M-Max adjustable frequency drives are explained in the appendix.

→ While planning the project, make sure that inching operation is not done via the mains contactor of the adjustable frequency drive on frequency-controlled drives, but through a controller input of the adjustable frequency drive.

The maximum permitted operating frequency of the mains voltage with the M-Max adjustable frequency drive is one time per minute (normal operation).

EMC measures

When planning the project for drive systems (PDS = Power Drive System) with adjustable frequency drives, you should take electromagnetic compatibility (EMC) measures into account. Improvements and changes to mounting and installing in the installation site are often accompanied with higher costs.

adjustable frequency drives do not work in inverters with fast electronic switches (IGBT). For this reason, radio interference can be caused in a PDS with adjustable frequency drives and this interference can have an effect on sensitive electronic devices in the vicinity (e.g. radio receivers, measuring devices, PLCs). To protect against these high-frequency interferences, you should install these (sensitive) devices distanced from one another and shielded from a frequency-controlled PDS.

In Europe, maintaining the EMC guidelines is mandatory.

The EMC product standard for drive systems (PDS) is the standard IEC/EN 61800-3. It covers the complete drive system (PDS), from the mains-side supply to the adjustable frequency drive to the motor, including cables (see figure 9, page 21). A drive system can consist of multiple drives as well. Generic standard components are not applicable here.

A declaration of conformity (CE) always refers to a "typical" drive system: adjustable frequency drives with specified cable length, allocated motor and radio noise elimination measures for a single drive. The responsibility for the complete drive system (PDS) is with the installer (e.g. mechanical engineer).

The M-Max adjustable frequency drive, with the integrated radio noise elimination filters, meets the requirements of the EMC product standard
IEC/EN 61800-3 for sensitive residential area (first environment) and therefore also the higher limit value in the industrial range (second environment).

Motor and Application

Motor selection

General recommendations for motor selection:

- Use three-phase powered asynchronous motors with short-circuit rotors and surface cooling, also called asynchronous motors or standard motors for the frequency-controlled drive system (PDS). Other specifications such as external rotor motors, slip-ring motors, reluctance motors, synchronous or servo motors can also be run with a adjustable frequency drive but normally require additional planning and discussion with the motor manufacturer.
- Use only motors with at least heat class F (155 °C maximum steady state temperature).
- 4-pole motors are preferred (synchronous speed: 1500 rpm at 50 Hz or 1800 rpm at 60 Hz).
- Take the operating conditions into account for S1 operation (IEC 60034-1).
- When operating multiple motors in parallel on one adjustable frequency drive, the motor output should not be more than three power classes apart.
- Avoid overdimensioning the motor. With an under-dimensioning in vector operation, the motor outptut is only allowed to be one power level less.

Connecting motors in parallel

The M-Max adjustable frequency drives allow parallel operation of several motors in V/Hz control mode:

- V/Hz control: several motors with the same or different rated operational data. The sum of all motor currents must be less than the adjustable frequency drive's rated current.
- V/Hz control: parallel control of several motors. The sum of the motor currents plus the motors' inrush current must be less than the adjustable frequency drive's rated current.

Parallel operation at different motor speeds can be implemented only by changing the number of pole pairs and/or changing the motor's transmission ratio.

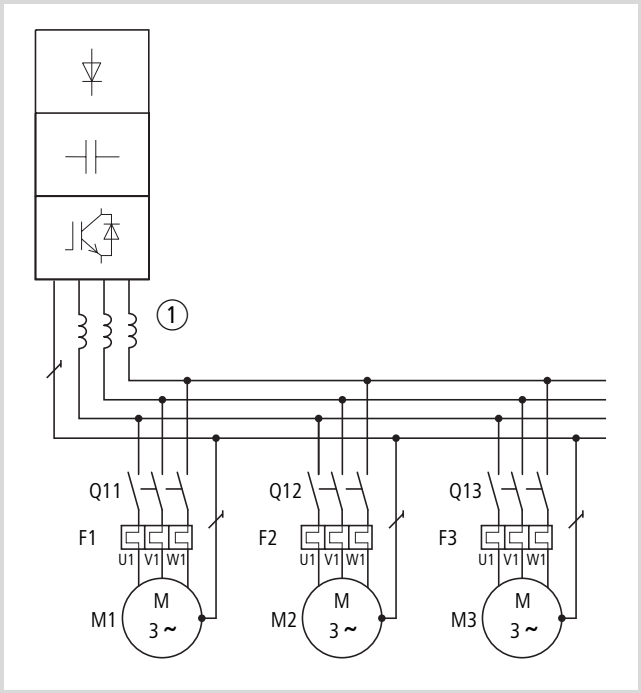


Figure 11: Parallel connection of several motors to one adjustable frequency drive

Caution!
If you are connecting multiple motors on one adjustable frequency drive, you must design the contactors for the individual motors according to utilization category AC-3.

Selecting the motor contactor is done according to the rated operational current of the motor to be connected.

Connecting motors in parallel reduces the load resistance at the adjustable frequency drive output. The total stator inductance is lower and the leakage capacity of the lines greater. As a result, the current distortion is greater than in a single-motor circuit. To reduce the current distortion, you should use motor reactors (see ① in figure 11) in the output of the adjustable frequency drive.

→ The current consumption of all motors connected in parallel must not exceed the adjustable frequency drive's rated output current I_{2N}.

→ Electronic motor protection can not be used when operating the adjustable frequency drive with several parallel connected motors. You must, however, protect each motor with thermistors and/or overload relays.

→ The use of motor-protective circuit-breaker at the adjustable frequency drive's output can lead to nuisance tripping.

Motor and circuit type

The motor's stator winding can be connected in a star or delta configuration in accordance with the rated operational data on the nameplate.

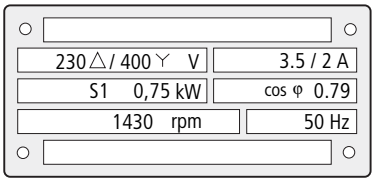


Figure 12: Example of a motor ratings plate

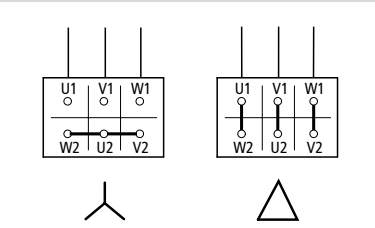


Figure 13: Circuit types: Star, Delta

The three-phase motor with the ratings plate based on figure 12, can be run in a star- or delta-circuit.
The operational characteristic curve is determined by the ratio of motor voltage and motor frequency in this case.

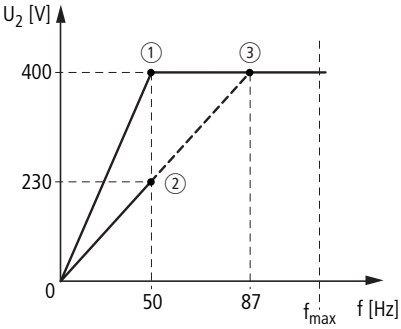


Figure 14: V/Hz-characteristic curve

① Star connection: 400 V, 50 Hz
② Delta connection: 230 V, 50 Hz
③ Delta connection: 400 V, 87 Hz

The following table 2 shows the allocation of possible adjustable frequency drives depending on the mains voltage and the type of circuit.

Table 2: Assignment of adjustable frequency drives to example motor circuit (figure 11)

adjustable frequency drives	**MMX12AA3D7…**	**MMX32AA3D7…**	**MMX34AA2D4…**	**MMX34AA4D3…**
Rated current	3.7 A	3.7 A	2.4 A	4.3 A
Mains voltage	1 AC 230 V	3 AC 230 V	3 AC 400 V	3 AC 400 V
Motor circuit	Delta	Delta	Star	Delta
V/Hz-characteristic curve	②	②	①	③
Motor current	3.5 A	3.5 A	2.0 A	3.5 A
Motor voltage	3 AC 0 to 230 V	3 AC 0 to 230 V	3 AC 0 to 400 V	3 AC 0 to 230 V
Motor speed	1430 rpm	1430 rpm	1430 rpm	2474 rpm [1)]
Motor frequency	50 Hz	50 Hz	50 Hz	87 Hz[1)]

1) Note the permitted limit values of the motor!

87-Hz Characteristic curve
In the delta circuit with 400 V and 87 Hz, the motor in figure 12 was released with 3-fold output (~ 1.3 kW).

Because of the higher thermal loading, only utilizing the next higher motor output according to the list (1.1 kW) is recommended. The motor (in this example) therefore still has 1.47-fold higher output compared with the listed output (0.75 kW).

With the 87-Hz characteristic curve, the motor also works in the range from 50 to 87 Hz with an unattenuated field. The pull-out torque remains at the same level as in mains operation with 50 Hz.

→ The heat class of the motor must be at least F in 87-Hz operation.

Bypass operation

If you want to have the option of operating the motor with the adjustable frequency drive or directly from the mains supply, the input branches must be interlocked mechanically.

▽ **Caution!**
A changeover between the adjustable frequency drive and the mains supply must take place in a voltage-free state.

⚠ **Caution!**
The adjustable frequency drive outputs (U, V, W) must not be
connected to the mains voltage (destruction of the device, risk of fire)

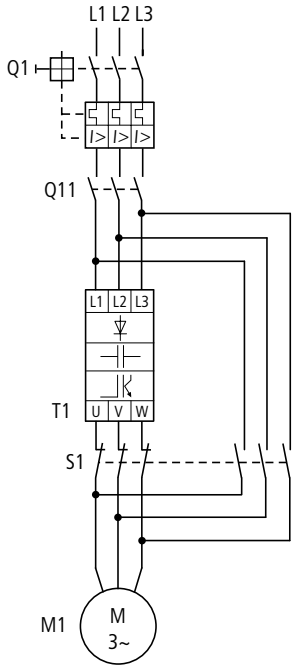


Figure 15: Bypass motor control (example)

▽ **Caution!**
Switch S1 must switch only when adjustable frequency drive T1 is at zero current.

→ Contactors and switches (S1) in the adjustable frequency drive output and for the direct start must be designed based on utilization category AC-3 for the rated operational current of the motor.

Connecting EX motors

Note the following when connecting explosion-protected motors please:

- The adjustable frequency drive must be installed outside the EX area.
- Note the branch- and country-specific standards for explosion-protected areas (ATEX 100a).
- Note the standards and information of the motor manufacturer regarding operation on adjustable frequency drives - e.g. if motor reactors (du/dt-limiting) or sinus filters are specified.
- Temperature monitors in the motor windings (thermistor, thermo-Click) are not to be connected directly to adjustable frequency drives but must be connected via an approved trigger apparatus for EX areas.

3 Installation

Introduction

This chapter provides a description of the installation and the electrical connections for the adjustable frequency drive M-Max series.

→ While installing and/or assembling the adjustable frequency drive, cover all ventilation slots in order to ensure that no foreign bodies can enter the device.

→ Perform all installation work with the specified tools and without the use of excessive force.

Installation guidelines

The instructions for installation in this manual apply for adjustable frequency drives of the M-Max series under protection class IP20.

In order to meet the requirements in accordance with NEMA 1 (IP21), you must, depending on the size of the housing, use the optional housing accessories MMX-IP21-FS1, MMX-IP21-FS2 or MMX-IP21-FS3.

The required installation instructions are shown in the setup instructions IL04020001E.

Mounting position

The vertical mounting position may be tilted by up to 90° degrees.

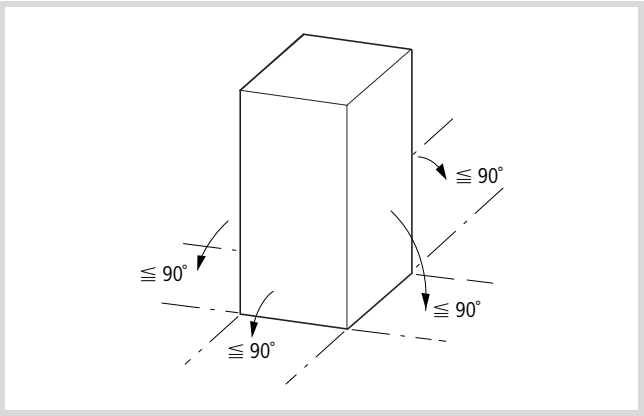


Figure 16: Mounting position

→ An installation that is turned by 180° (stood on its head) is not permitted.

Cooling measures

In order to guarantee sufficient air circulation (thermal), free space of at least 100 mm above the adjustable frequency drive M-Max and at least 50 mm under the adjustable frequency drive is required.

The required cooling airflow is 10 m^3/h for sizes FS1 and FS2 and 30 m^3/h for size FS3 (refer to section "Dimensions and frame size" in the appendix on page 115).

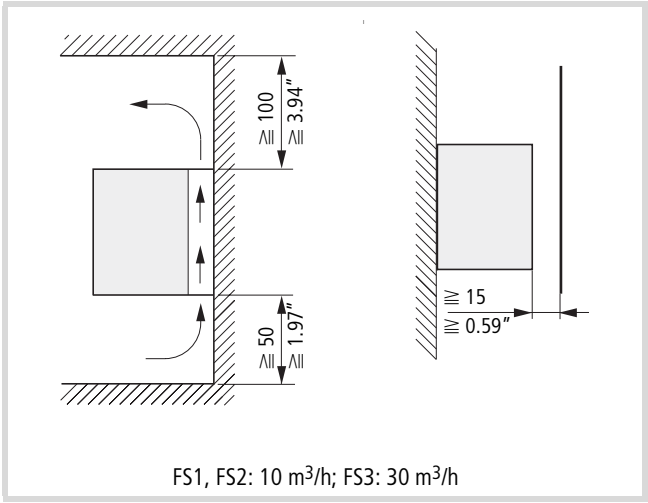


Figure 17: Space for air-cooling

The space in front should not be under 15 mm.

→ Please note that the installation makes it possible to open and close the control signal terminal covers without any problems.

→ The adjustable frequency drives of the M-Max series are air-cooled with an internal fan.

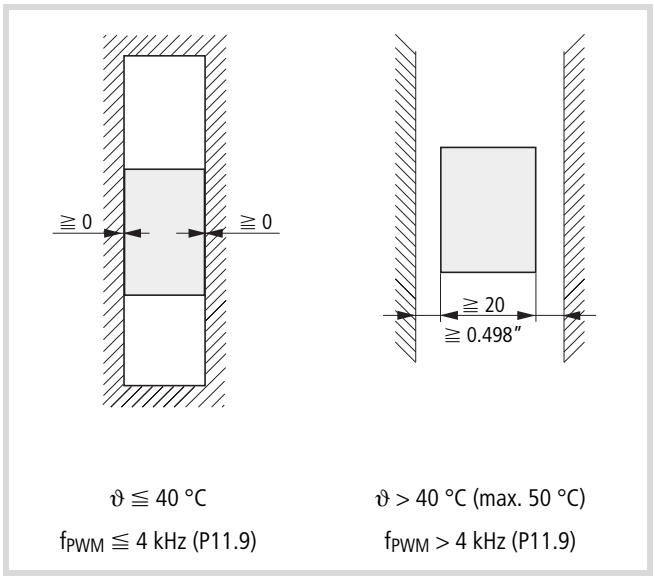


Figure 18: Free space at the sides

Up to an ambient temperature of +40 °C, a set-up height of up to 1000 m and a pulse-frequency of up to 4 kHz, the adjustable frequency drives of the M-Max series do not require any space at the sides.

Higher ambient temperatures (up to a maximum of +50 °C), pulse frequencies f_{PWM} (up to maximum 16 kHz) and set-up heights (up to 2000 m) require space on the sides of at least 20 mm.

→ The pulse frequency (f_{PWM}) can be adjusted with parameter P11.9.

→ Devices with high magnetic fields (e. g. inductors or transformers) should not be installed close to the M-Max device.

Fixing

You can mount an M-Max adjustable frequency drive on screw mounts or on a mounting rail.

→ Install the adjustable frequency drive only on a nonflammable mounting base (e.g., on a metal plate).

→ Dimensions and weights of the adjustable frequency drive M-Max are located in the appendix.

Fastening with screws

The number and arrangement of required bore holes (mounting dimensions a1 and b1 in figure 19) are also imprinted in the base plate of the M-Max device.

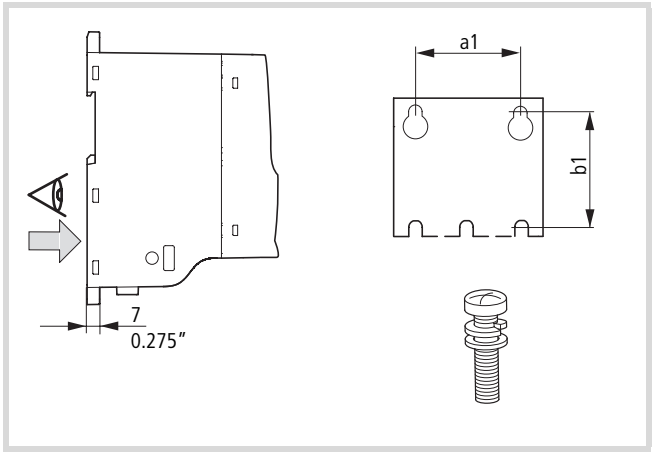


Figure 19: Mounting dimensions

Install the screws in the specified positions first. Then set the adjustable frequency drive on the prepared wall-mount and tighten all screws. The permitted maximum tightening torque for the fastening screws is 1.3 Nm.

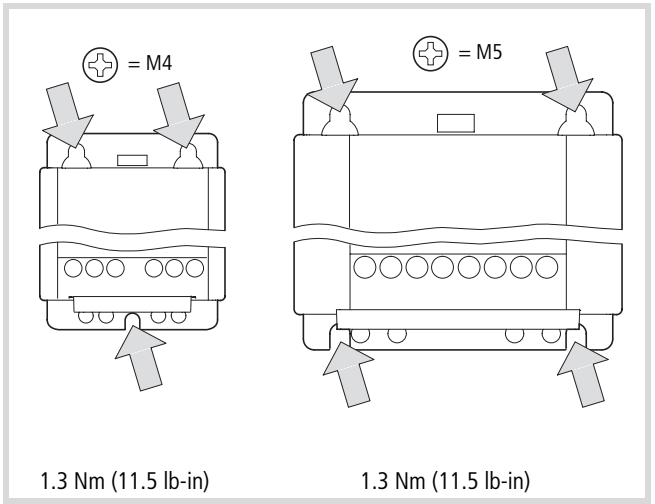


Figure 20: Configuration for mounting with screws

Fastening on mounting rails
As an alternative, you can also fasten to a mounting rail conforming with IEC/EN 60715.

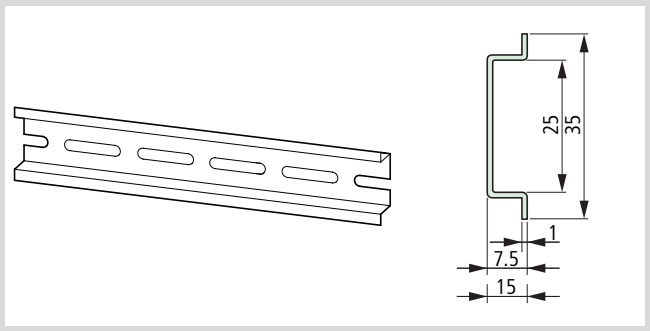


Figure 21: Mounting rail conforming with IEC/EN 60715

Set the adjustable frequency drive onto the mounting rail [1] from above and press until is rests in place [2].

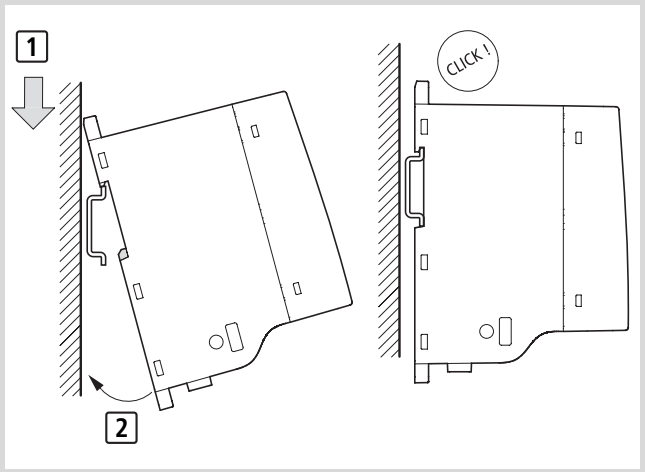


Figure 22: Fastening to the mounting rail

Dismountling from mounting rails
To remove the device, you must press the spring-loaded latch downward. A marked gap is provided on the top edge of the M-Max device for this.
To unlatch it, a screwdriver with a flat edge is recommended (e.g. blade width 5 mm).

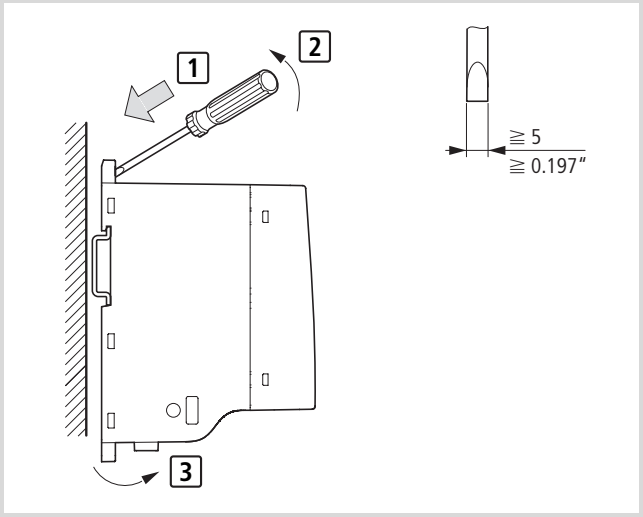


Figure 23: Dismounting

Cable flange plate (Accessories)
An accessories pack with cable router plate and brackets are included within the scope of delivery of the M-Max. You can then route the connecting lines directly on the adjustable frequency drive and fasten shielded cables properly in accordance with EMC-guidelines if necessary.

First, install the cable clamp plate for the connection lines in the power section [1] and then the cable clamping plate [2] for the control lines. The required installation screws (M4) included as standard.
[3] = gland plates in the power section.

→ Mount the cable routing plate before the electrical installation.

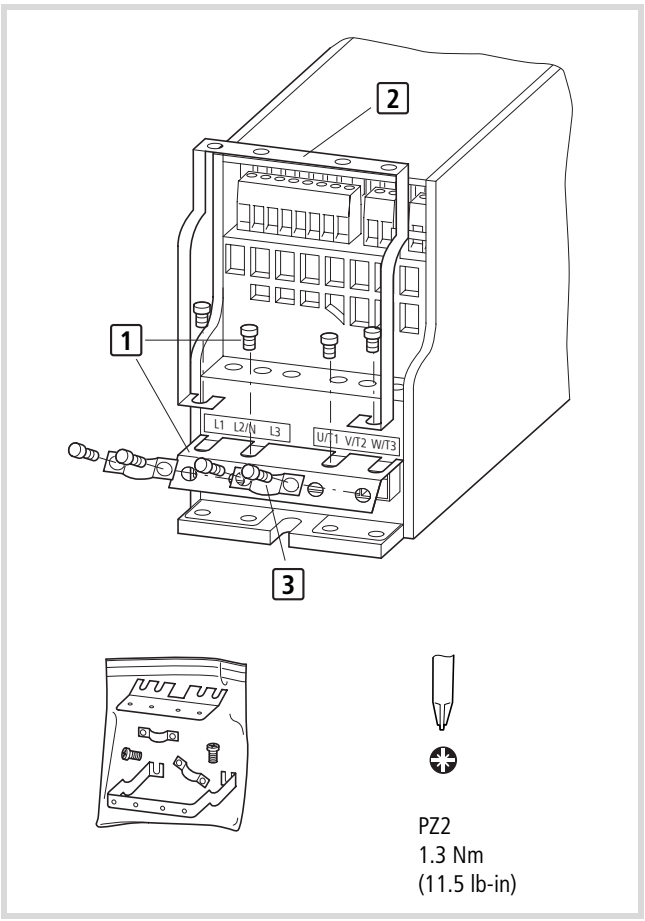


Figure 24: Mounting the cable routing plate and the brackets

EMC-compatible installation

In a drive system (PDS) with adjustable frequency drives, you should take measures for electromagnetic compatibility (EMC) while doing your planning, since changes or improvements to the installation site, which are required in the installation or while mounting, are normally associated with additional higher costs as well.

Leakage currents are frequently found in a drive system during operation of a adjustable frequency drive for technological and system-related reasons. Therefore, all grounding measures must be kept at low resistance and over a broad area.

With leakage currents greater than 3.5 mA, in accordance with VDE 0160 or EN 60335, either

- the protective conductor must have a cross-section $\geqq$ 10 mm^2,
- the protective conductor must be open-circuit monitored, or
- the second protective conductor must be fitted.

For an EMC-compliant installation, we recommend the following measures:

- Installation of the adjustable frequency drive in a metallically conductive housing with a good connection to ground,
- shielded motor cables (short cable lengths).

Ground all conductive components and housings in a drive system using as short a line as possible with the greatest possible cross-section (Cu-braid).

EMC measures in the control panel

For the EMC-compatible installation, connect all metallic parts of the device and the switching cabinet together over broad surfaces and so that high-frequencies will be conducted. Mounting plates and cabinet doors should make good contact and be connected with short HF-braided cables. Avoid using painted surfaces (Anodized, chromized). An overview of all EMC measures is provided in figure 25 on page 36.

- ▶ Install the adjustable frequency drive as directly as possible (without spacers) on a metal plate (mounting plate).
- ▶ Run the power and motor cables as close to a ground potential in the cabinet. Free lines work like antennas.
- ▶ If you run HF lines (e. g. shielded motor cables) and interference-suppressed lines (e. g. power lines, control and signal lines) are run in parallel, the distance between them should be at least 300 mm to prevent electromagnetic interference. You should also use separate cable guides if there is a great difference in voltage potentials. Whenever control lines and power lines have to cross one-another, they should cross at right angles (90 degrees).
- ▶ Never lay control or signal cables in the same duct as power cables. Analog signal cables (measured, reference and correction values) must be shielded.

Grounding

The ground connection (PE) in the cabinet should be connected from the mains supply to a central grounding point (mounting plate). All ground conductors should be routed in star formation from this grounding point and all conductive components of the PDS (adjustable frequency drive, motor reactor, motor filter, mains reactor) are to be connected..

Avoid ground loops when installing multiple adjustable frequency drives in one cabinet. Make sure that all metallic devices that are to be grounded have a broad area connection with the mounting plate.

Shielding

Cables that are not shielded work like antennas (sending, receiving). Make sure that any cables that may carry disruptive signals (e.g. motor cables) and sensitive cables (analog signal and measurement values) are shielded apart from one another with EMC-compatible connections.

The effectiveness of the cable shield depends on a good shield connection and a low shield impedance.

Use only shields with tinned or nickel-plated copper braiding. Braided steel shields are unsuitable.

→ Control and signal lines (analog, digital) should always be grounded on one end, in the immediate vicinity of the supply voltage source (PES).

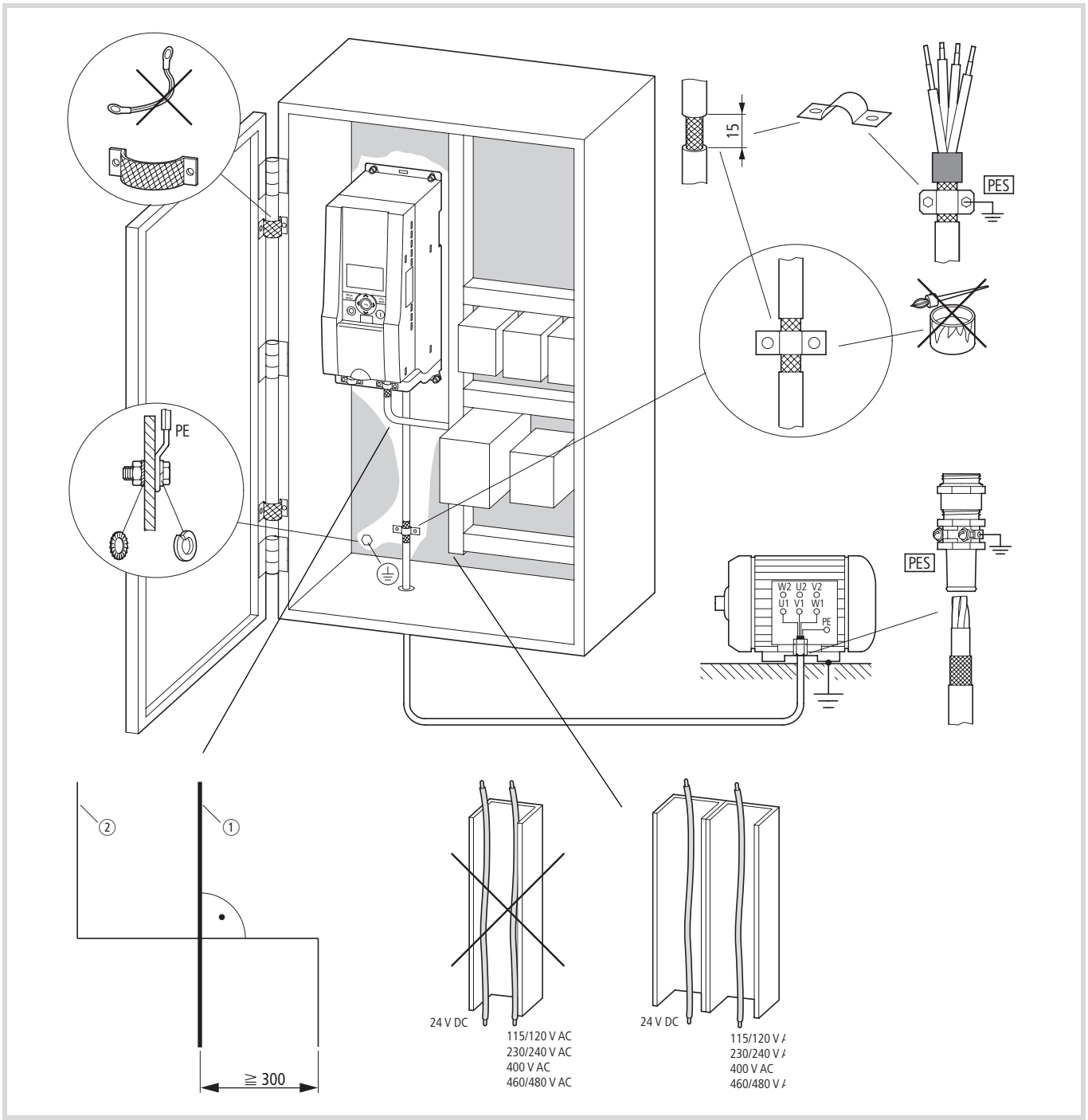


Figure 25: EMC-compliant setup

Example: M-Max

① Power cable: L1, L2/N, L3 and U/T1, V/T2, W/T3, R+, R-

② Control and signal lines: 1 to 26, A, B, fieldbus connection

Large-area connection of all metallic control panel components.

Mounting surfaces of adjustable frequency drive and cable shielding must be free from paint.

Cable shielding of cables at adjustable frequency drive's output with earth potential (PES) across large surface area

Large-area cable shield contacts with motor.

Large-area earth connection of all metallic parts.

Electrical Installation

Warning!
Carry out wiring work only after the adjustable frequency drive has been correctly mounted and secured.

Danger!
Electric shock hazard - risk of injuries!

Carry out wiring work only if the unit is de-energized.

Caution!
Fire hazard!

Only use cables, protective switches, and contactors that feature the indicated permissible nominal current value.

Caution!
Ground contact currents in adjustable frequency drives are greater than 3.5 mA (AC). According to product standard IEC/EN 61800-5-1, an additional equipment grounding conductor must be connected, or the cross-section of the equipment grounding conductor must be at least 10 mm^2.

Danger!
The components in the adjustable frequency drive's power section remain energized up to five (5) minutes after the supply voltage has been switched off (intermediate circuit capacitor discharging time).

Pay attention to hazard warnings!

→ Complete the following steps with the specified tools and without using force.

Power section connections

The following figure shows the general connections for the adjustable frequency drive in the power section.

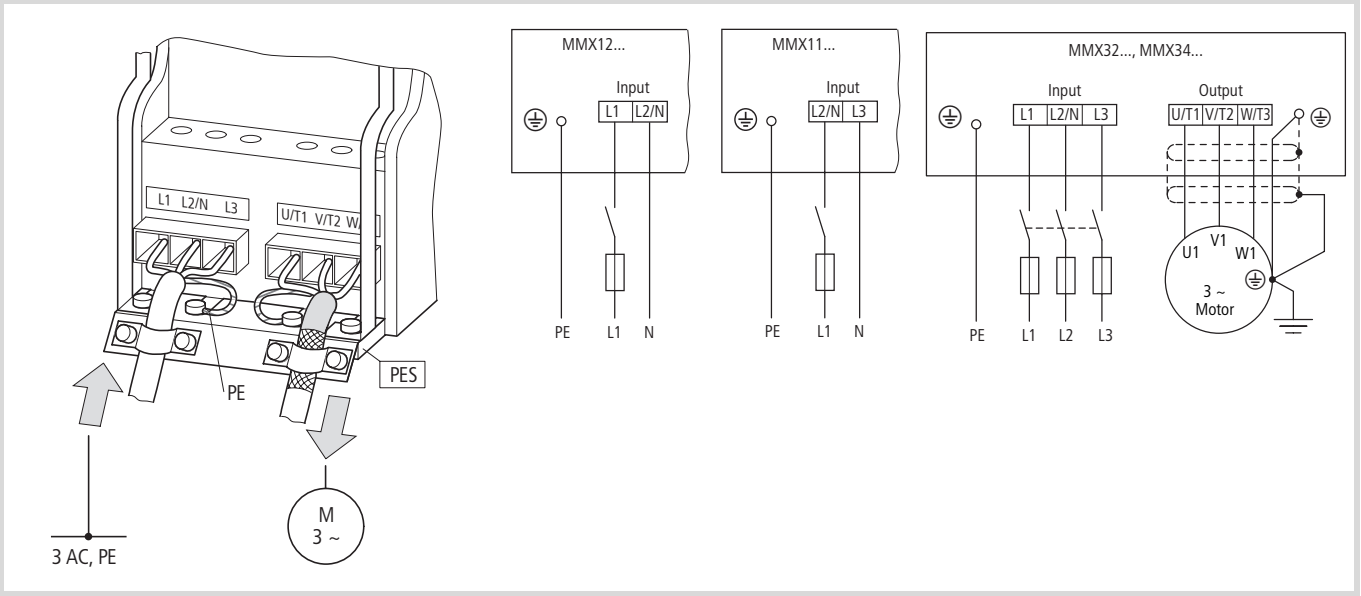


Figure 26: Connection to power section

Terminal designations in the power section

- L1, L2/N, L3: Connection terminals for the supply voltage (input, mains voltage):
  - Single phase AC voltage:
    Connection to L2/3 and L3 with MMX11…
  - Single phase AC voltage:
    Connection to L1 and L2/N with MMX12…
  - Three-phase AC voltage:
    Connection to: L1, L2/, L3 with MMX32… and MMX34…
- U/T1, V/T2, W/T3: Connection terminals for the three-phase line to the AC motor (output, adjustable frequency drive)
- R+, R-: Connection terminals for external brake resistance (only with MMX34…, output braking transistor)
- ⏚, PE: Connection for protective ground (reference potential). PES with mounted cable clamp plate for shielded lines.

→ The adjustable frequency drive must always be connected with ground potential via a grounding conductor (PE).

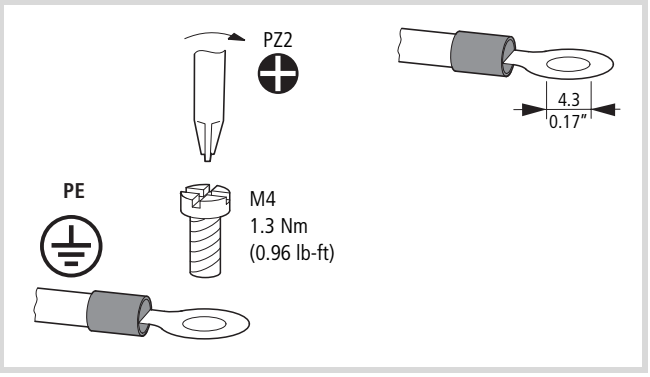


Figure 27: Ground connection

The ground connection is connected directly with the cable clamp plates.

The shielded cables between the adjustable frequency drive and the motor should be as short as possible. Connect the shielding on both ends and over a large surface area with protective ground PES (Protective Earth Shielding). You can connect the shielding of the motor cable directly to the cable clamp plate (360 degrees coverage) with the protective ground.

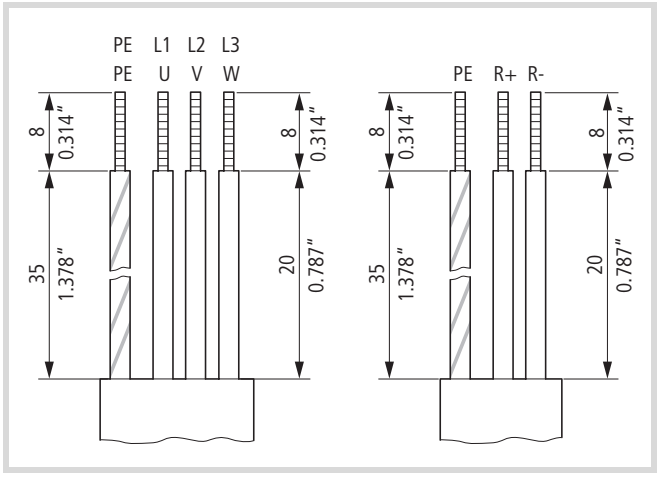


Figure 28: Connection in power section

Prevent the shielding from becoming unbraided, i.e. by pushing the separated plastic covering over the end of the shielding or with a rubber grommet on the end of the shielding. As an alternative, in addition to a broad area cable clip, you can also twist the shielding braid at the end and connect to protective ground with a cable clip. To prevent EMC disturbance, this twisted shielding connection should be made as short as possible (see figure 30).

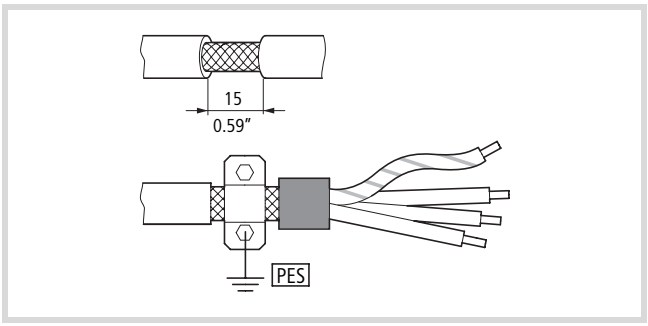


Figure 29: Shielded connecting line

Shielded, four-wire cable is recommended for the motor cables. The green-yellow line of this cable connects the protective ground connections from the motor and the adjustable frequency drive and therefore minimizes the equalizing current loads on the shielding braid.

Twisted shielding braid should be connected with a ring cable terminal (see figure 27, page 38) on PES.

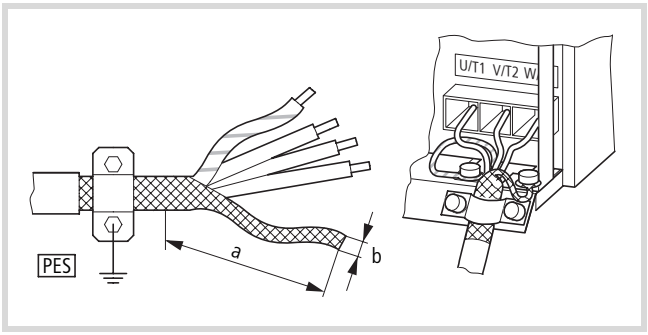


Figure 30: Connection with twisted cable shielding
Recommended value for twisted cable shielding:
b ≧ 1/5 a

The following figure shows the construction of a four-wire, shielded motor line (recommended specifications).

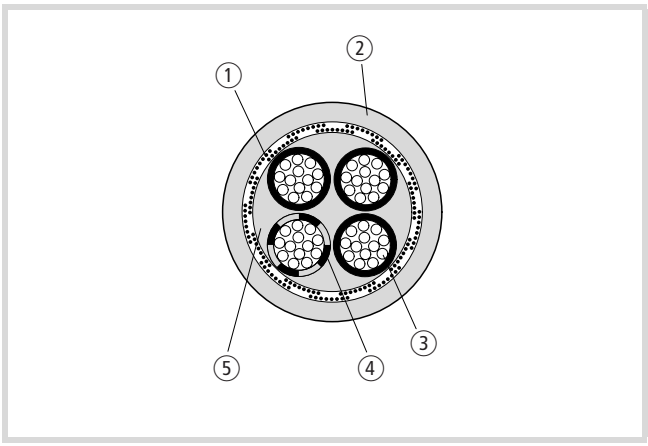


Figure 31: Four-core shielded motor supply cable

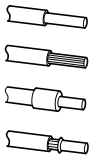
① Cu shield braid
② PVC outer sheath
③ Drain wire (copper strands)
④ PVC core insulation, 3 x black, 1 x green–yellow
⑤ Textile and PVC fillers

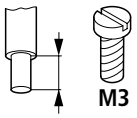
If there are additional subassemblies in a motor circuit (i.e. motor contactors, relays, motor reactor, sinusoidal filters or terminals), interrupt the shielding of the motor cable in the vicinity of these subassemblies. Connect this over a broad surface area with the mounting plate (PES). Free or non-shielded connection cables should not be any longer than about 300 mm.

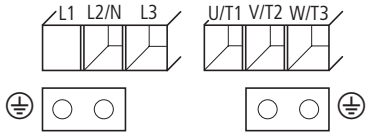
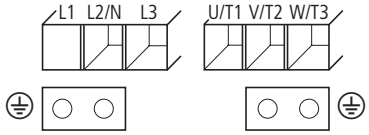
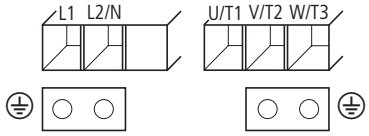
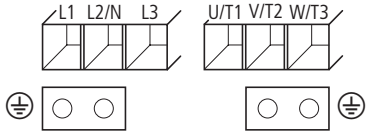
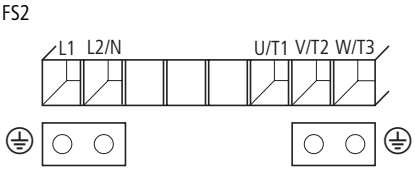
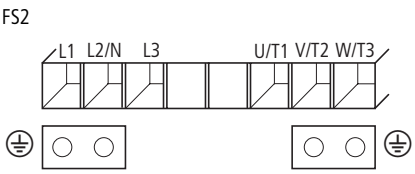
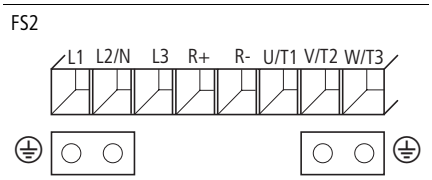
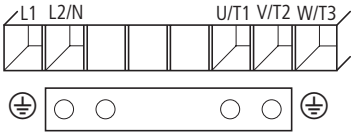
Arrangement and connection of the power terminals

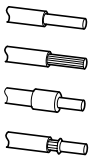
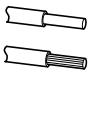
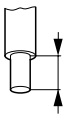
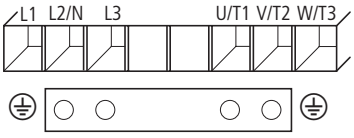
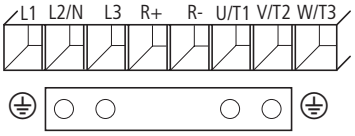
The arrangement and size of the connection terminals depends on the construction of the power section (FS1, FS2, FS3).

The cross-sections to use in the connections, the tightening torques for screws and respective fuses are listed in the following.





	mm²	AWG	mm	Nm	ft-lbs	mm	
MMX11AA1D7N0-0 MMX11AA2D4N0-0 MMX11AA2D8N0-0 MMX11AA3D7N0-0	0.2 – 4	24 –10	8	0.5 –0.6	0.37 – 0.44	0.6 x 3.5	FS2 
MMX11AA4D8N0-0	0.2 – 4	24 –10	8	0.5 –0.6	0.37 – 0.44	0.6 x 3.5	FS3 
MMX12AA1D7F0-0 MMX12AA2D4F0-0 MMX12AA2D8F0-0 MMX12AA3D7F0-0	0.2 – 2.5	24 –12	8	0.5 –0.6	0.37 – 0.44	0.6 x 3.5	FS1 
MMX32AA1D7F0-0 MMX32AA2D4F0-0 MMX32AA2D8F0-0 MMX32AA3D7F0-0 MMX34AA1D3F0-0 MMX34AA1D9F0-0 MMX34AA2D4F0-0 MMX34AA3D3F0-0	0.2 – 2.5	24 – 12	8	0.5 – 0.6	0.37 – 0.44	0.6 x 3.5	FS1 
MMX12AA4D8F0-0 MMX12AA7D0F0-0	0.2 – 2.5	24 – 12	8	0.5 – 0.6	0.37 – 0.44	0.6 x 3.5	FS2 
MMX32AA4D8F0-0 MMX32AA7D0F0-0	0.2 – 2.5	24 – 12	8	0.5 – 0.6	0.37 – 0.44	0.6 x 3.5	FS2 
MMX34AA4D3F0-0 MMX34AA5D6F0-0	0.2 – 2.5	24 – 12	8	0.5 – 0.6	0.37 – 0.44	0.6 x 3.5	FS2 
MMX12AA9D6F0-0	0.2 – 4	24 – 10	8	0.5 – 0.6	0.37 – 0.44	0.6 x 3.5	FS3 

				M3			
	mm²	**AWG**	**mm**	**Nm**	**ft-lbs**	**mm**	
MMX32AA011F0-0	0.2 – 4	24 – 10	8	0.5 – 0.6	0.37 – 0.44	0.6 x 3.5	FS3 
MMX34AA7D6F0-0 MMX34AA9D0F0-0 MMX34AA012F0-0 MMX34AA014F0-0	0.2 – 4	24 – 10	8	0.5 – 0.6	0.37 – 0.44	0.6 x 3.5	FS3 

Connection on control section

The control signal terminals are arranged under the frontal cover flap.

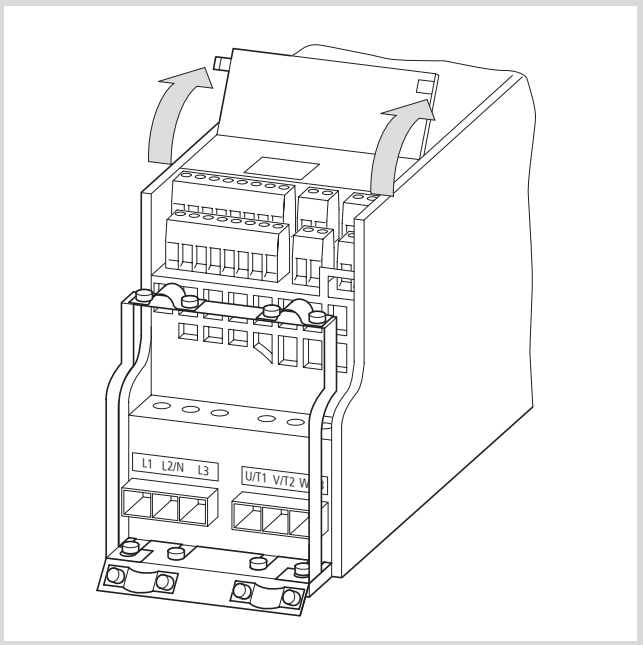


Figure 32: Position of control signal terminals

The cable hold down clamps contained in the scope of delivery can be mounted on the cable clamp plate of the power section.

The control lines should be shielded and twisted. The shielding is exposed on one side (PES) – on the cable hold down clamps on the adjustable frequency drive for instance.

Prevent the shielding from becoming unbraided, i.e. by pushing the separated plastic covering over the end of the shielding or with a rubber grommet on the end of the shielding.

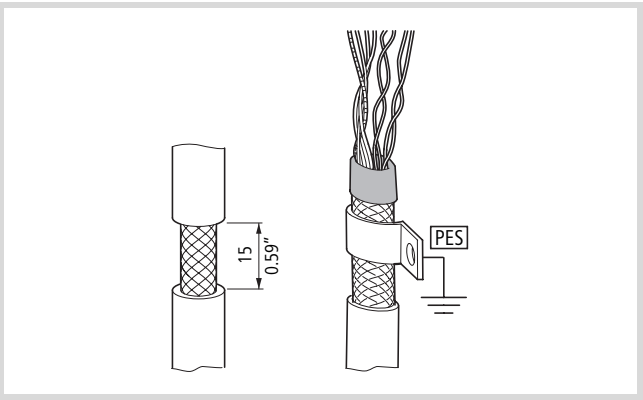


Figure 33: Preventing shielding from becoming unbraided

As an alternative, in addition to a broad area cable clip, you can also twist the shielding braid at the end and connect to protective ground with a cable clip. To prevent EMC disturbance, this twisted shielding connection should be made as short as possible (see figure 30 on page 39.).

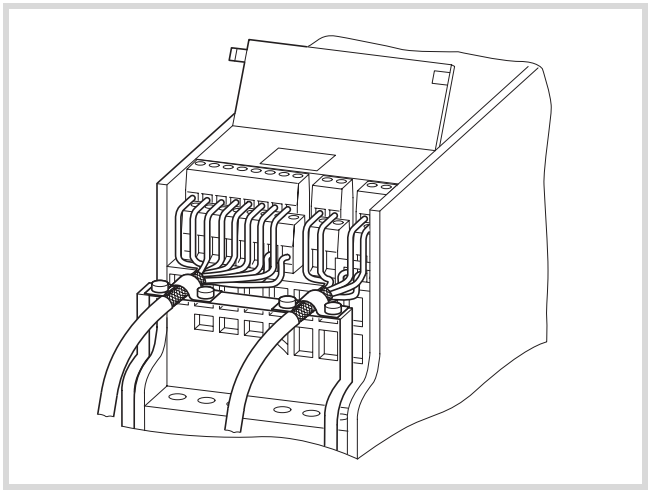


Figure 34: Example for a single-side connection (PES) to the adjustable frequency drive

On the other end of the control line, you should prevent any unraveling with a rubber grommet. The shielding braid is not to make any connection with protective ground here because this would cause problems with an interference loop.

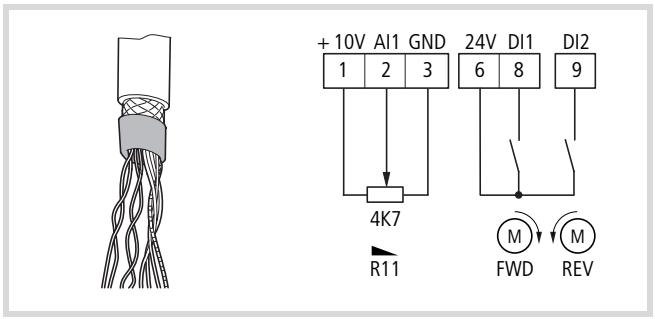


Figure 35: Example for an insulated end of the control cable

Arrangement and connection of the control signal terminals

The following figure shows the arrangement and designation of the control signal terminals of the M-Max.

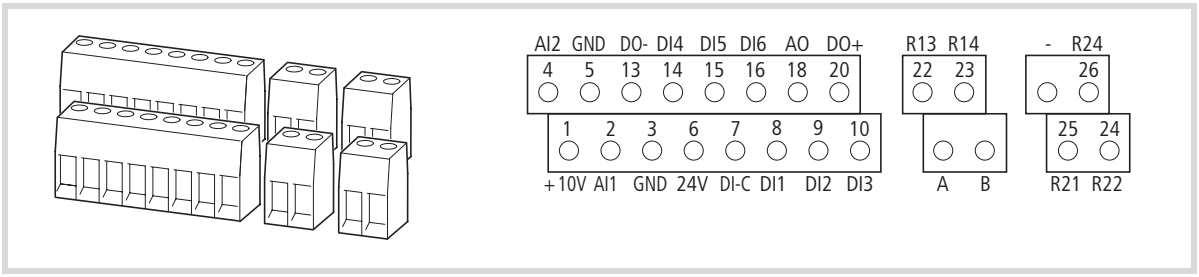
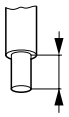


Figure 36: Assignments and designations for control signal terminals

Table 3: Possible sizes and specifications of the connection lines on the control signal terminals

				M3		
mm²	**mm²**	**AWG**	**mm**	**Nm**	**ft-lbs**	**mm**
0.25 – 0.5	0.14 – 1.5	26 – 16	5	0.22 – 0.25	0.16 – 0.18	0.4 x 2.5

Function of the control signal terminals

The functions that are set in the factory and the electrical connection data of all control signal terminals are listed in the following table.

Table 4: Factory-set functions of the control terminals

Terminal		Signal	Factory setting	Description
1	+10V	Output nominal voltage	-	Maximum load 10 mA, Reference potential GND
2	AI1	Analog signal input 1	Frequency reference value[1)]	0 – +10 V (R_i > 200 kΩ)
3	GND	Reference potential	-	0 V
6	24V	Control voltage for DI1 to DI6, output (+24 V)	-	Maximum load 50 mA, reference potential GND
7	GND	Reference potential	-	0 V
8	DI1	Digital input 1	FWD start enable, forward[1)]	0 – +30 V (R_i > 12 kΩ)
9	DI2	Digital input 2	REV start enable, reverse[1)]	0 – +30 V (R_i > 12 kΩ)
10	DI3	Digital input 3	Fixed frequency B0	0 – +30 V (R_i > 12 kΩ)
4	AI2	Analog input 2	PI actual value[1)]	0 (4) – 20 mA (R_B = 200 Ω)
5	GND	Reference potential	-	0 V
13	GND	Reference potential	-	0 V
14	DI4	Digital input 4	Fixed frequency B1	0 – +30 V (R_i = 12 kΩ)
15	DI5	Digital input 5	Error acknowledgment[1)]	0 – +30 V (R_i = 12 kΩ)
16	DI6	Digital input 6	PI controller deactivated[1)]	0 – +30 V (R_i = 12 kΩ)
18	AO	Analog output	Output frequency[1)]	0 (4) – 20 mA (R_B = 500 Ω)
20	DO	Digital output	Active = READY[1)]	Open collector, maximum load: 48 V, 50 mA, reference potential: GND
A	A	RS485 signal A	BUS-Communication	Modbus RTU
B	B	RS485 signal B	BUS-Communication	Modbus RTU
22	R13	Relay 1, normally open contact	Active = RUN[1)]	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
23	R14	Relay 1, normally open contact	Active = RUN[1)]	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
24	R21	Relay 2, changeover contact	Active = FAULT[1)]	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
25	R22	Relay 2, changeover contact	Active = FAULT[1)]	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
26	R24	Relay 2, changeover contact	Active = FAULT[1)]	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A

1) Programmable function (see parameter list in appendix, page 118)

Analog inputs
The adjustable frequency drive M-Max has two analog inputs for specifying the frequency setpoint value and the actual value return to the PI controller:

- Terminal 2 (AI1), voltage signal 0 (2) – +10 V,i input resistor 200 kΩ
- Terminal 4 (AI2), current signal 0 (4) – 20 mA, load resistor 200 Ω

Adjusting and the parameter definition of analog inputs are described in section "Analog input (P2)", page 73.

The analog input AI1 (Terminal 2) has default setting for the frequency setpoint value (P6.2). The setpoint input can be done via an external potentiometer for instance (recommended fixed resistance 1 kΩ to 10 kΩ). The fixed resistance of the setpoint potentiometer is supplied by the adjustable frequency drive via terminal 1 with +10 V (maximum load rating: 10 mA). Reference point (GND) for the analog setpoint value signals are terminals 3, 5, 7 or 13.

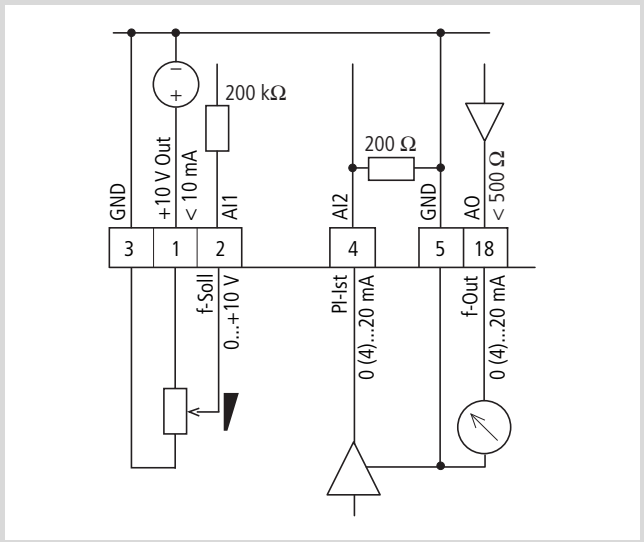


Figure 37: Analog setpoint value inputs AI1 and AI2
Connection example: Potentiometer (4.7 kΩ)
M22-R4K7; Article No. 229490

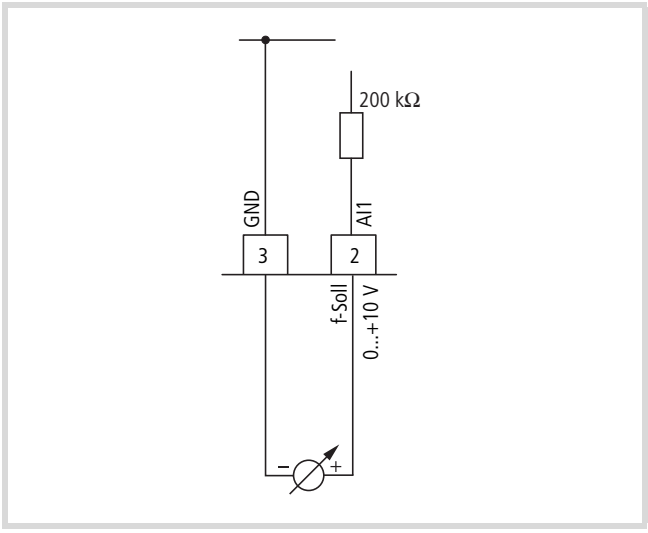


Figure 38: Analog setpoint value signal – e. g. from a superordinate controller (PLC)

Analog output
On terminal 18, the adjustable frequency drive provides an analog current signal (4 – 20 mA). This signal is set proportional to the output frequency in the factory (0 – f_{max}). Adjustments and parameter definitions for the analog outputs are described in section "Analog output (P4)", page 78.

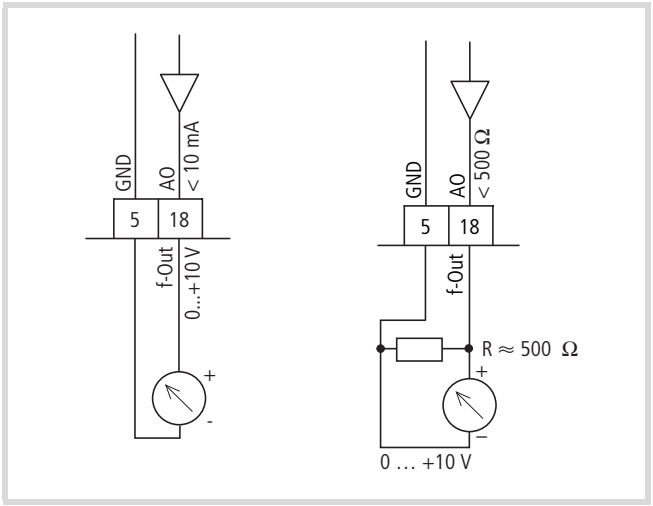


Figure 39: Analog output AO (connection examples)

You can shape the current signal into a proportional voltage signal with a load resistor (500 Ω, 0.25 W). Note: Instead of 500 Ω, you can also connect two 1 kΩ (Standard value) resistors with 0.125 W each in parallel.

Digital inputs
Range of digital and analog inputs and outputs.

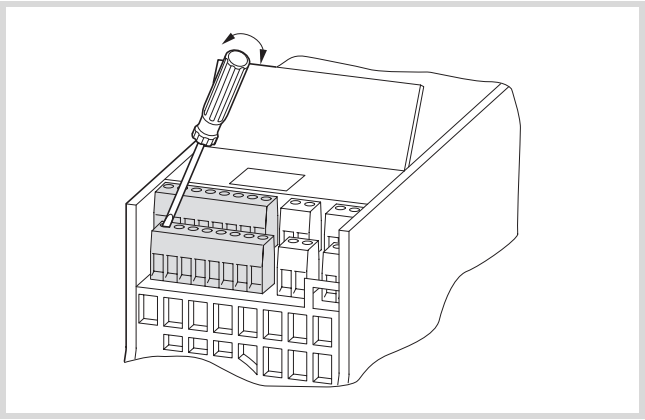


Figure 40: Control signal terminals (digital and analog inputs/outputs)

The adjustable frequency drive has six digital inputs (DI1 to DI6), which are identical in their functionality and operation. The actuation is done with +24 V. Yuu can use the device-internal control voltage from terminal 6 (+24 V, maximum 50 mA) or an external voltage source (+24 V) with a residual ripple of less than ±5 % $\Delta U_a/U_a$ for this. The functions for which parameters can be defined are described in section "Digital input (P3)", page 75.

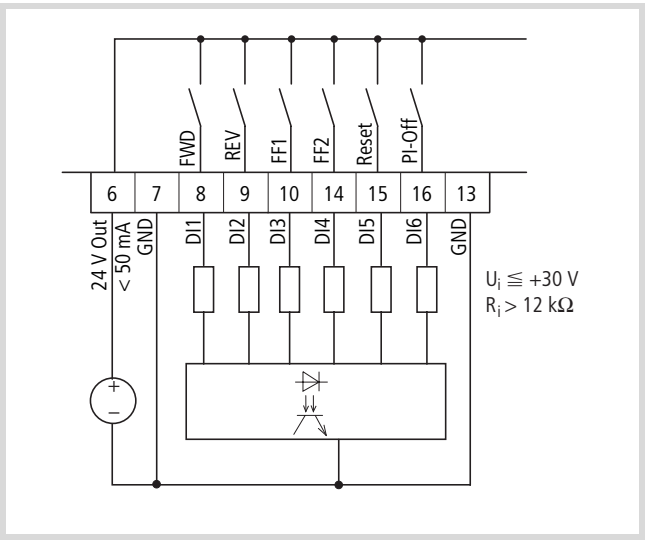


Figure 41: Digital inputs with internal supply voltage

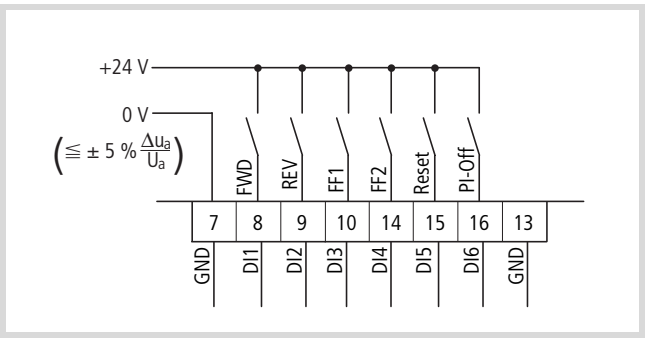


Figure 42: Digital inputs with external supply voltage

The functions set in the factory and the electrical connection data is provided in section "Function of the control signal terminals", page 44.

Digital output (Transistor)
The transistor output (Open Collector) switches terminal 20 to the internal reference potential GND. The maximum permitted load current is 50 mA (+48 V).

As supply voltage, you can connect the device-internal control voltage from terminal 6 (+24 V, maximum 50 mA) or an external voltage source (+24 V), the residual ripple of which is less than ±5 % $\Delta U_a/U_a$. The functions for which parameters can be defined are described in section "Digital output (P5)", page 79.

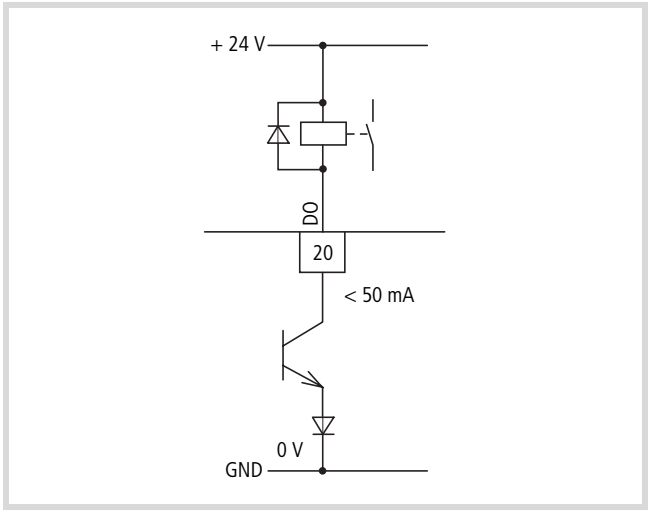


Figure 43: Digital output DO (activity)

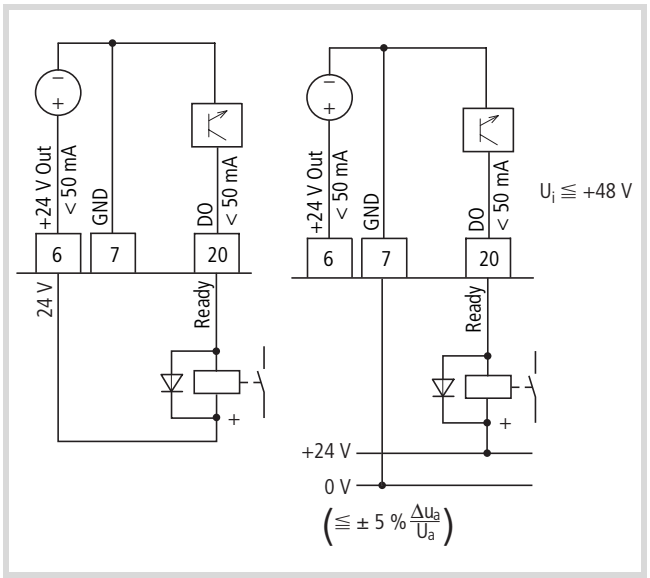


Figure 44: Digital output DO and connection examples (coupling relay with freewheeling diode)

Digital outputs (relays)
The following figure shows the arrangement of the connection terminals for both relay contacts.

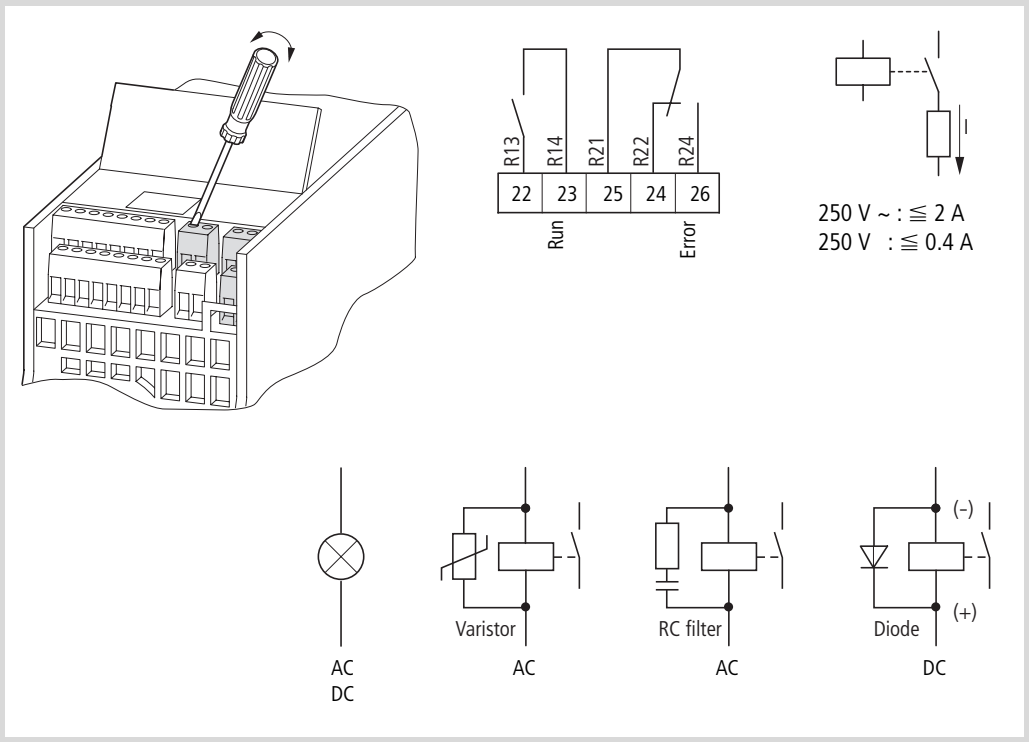


Figure 45: Relay outputs with connection examples: Control relay with suppressor circuit

The two relay outputs (Terminals 22 to 26) enable the adjustable frequency drive electrically isolated feedback responses in a control circuit with other potentials:

- maximum switching capacity: 250 V DC, 0.4 A (DC voltage)
- maximum switching capacity: 250 V AC, 2 A (AC voltage)

→ With voltages greater than 24 V, you should fasten the connection cables of the relay in the opening on the right (housing).

The functions for which parameters can be defined are described in section "Digital output (P5)", page 79.

Open contacts R13/R14 (terminal 22/23) of relay RO1 indicate the operation (RUN) with factory default settings.

The N/O R22/R24 (terminal 25/26) from relay RO2 indicate a detected fault (ERROR = FAULT).

→ If the supply voltage of the adjustable frequency drive is switched off upon the occurrence of an error message, the N/O R22/R24 opens again (relay drops out).

The functions for which parameters can be defined for both relays RO1 and RO2 are described in section "Digital output (P5)", page 79.

Serial interface A-B MODBUS

The following figure shows the connections of the serial interface and the position of the micro-switch for the bus termination resistor.

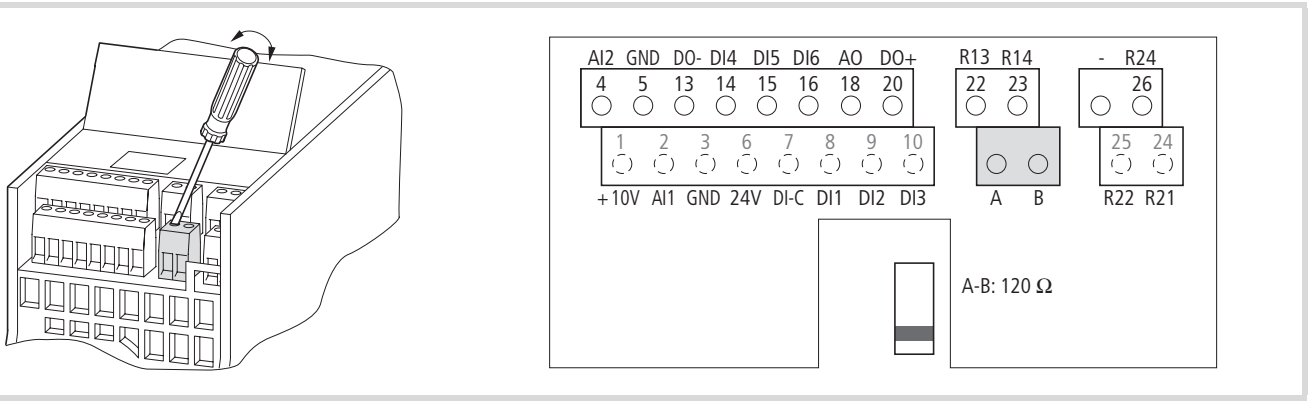


Figure 46: Serial interface with micro-switch S1 (bus termination resistor)

Both control terminals A and B allow the connection of a shielded RS485 twisted-pair cable. The required bus termination resistor on the end of the data cable is built into the adjustable frequency drive and can be connected via micro-switch S1.

→ The network cable must have a bus termination resistor (120 Ω) connected at each physical end to prevent reflections and the resulting transmission faults.

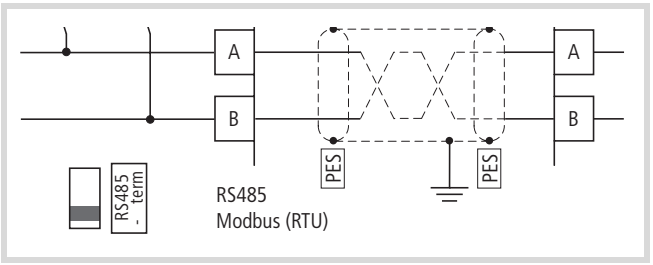


Figure 47: Two-wire RS485 connection
(Slave = adjustable frequency drive M-Max)

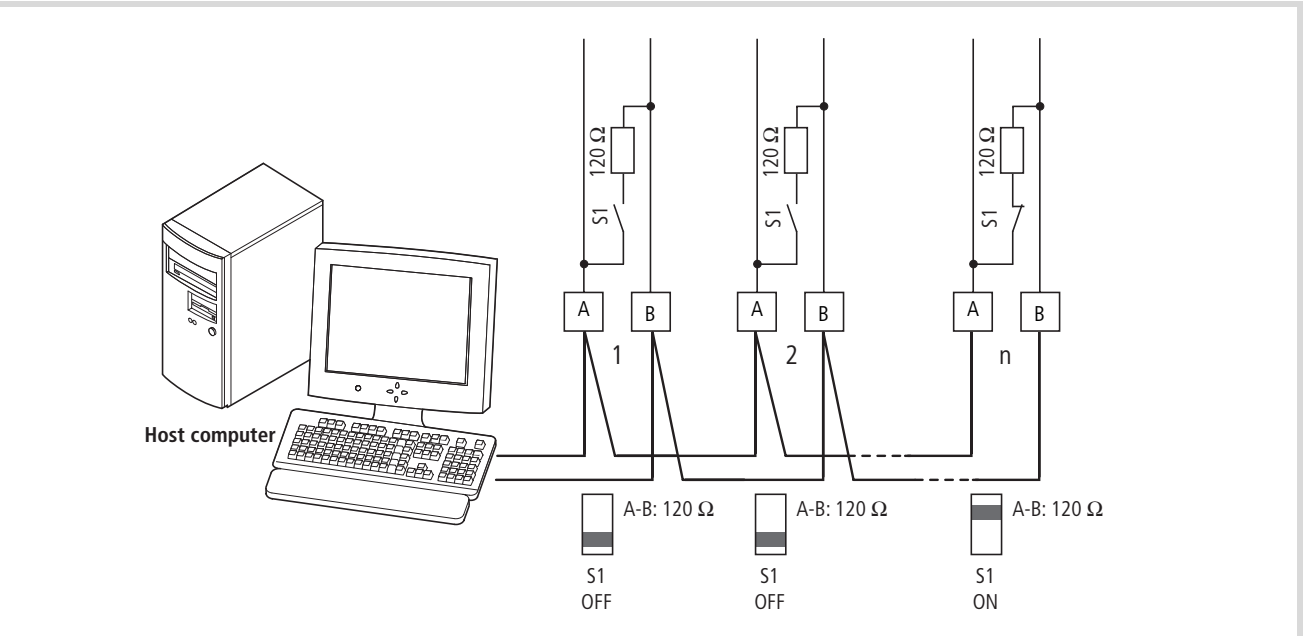


Figure 48: Bus connection with multiple nodes

The parameter definition of the serial interface is described in chapter "Serial interface (Modbus RTU)".

Block diagram

The following diagrams show all the connection terminals of M-Max adjustable frequency drive and default settings.

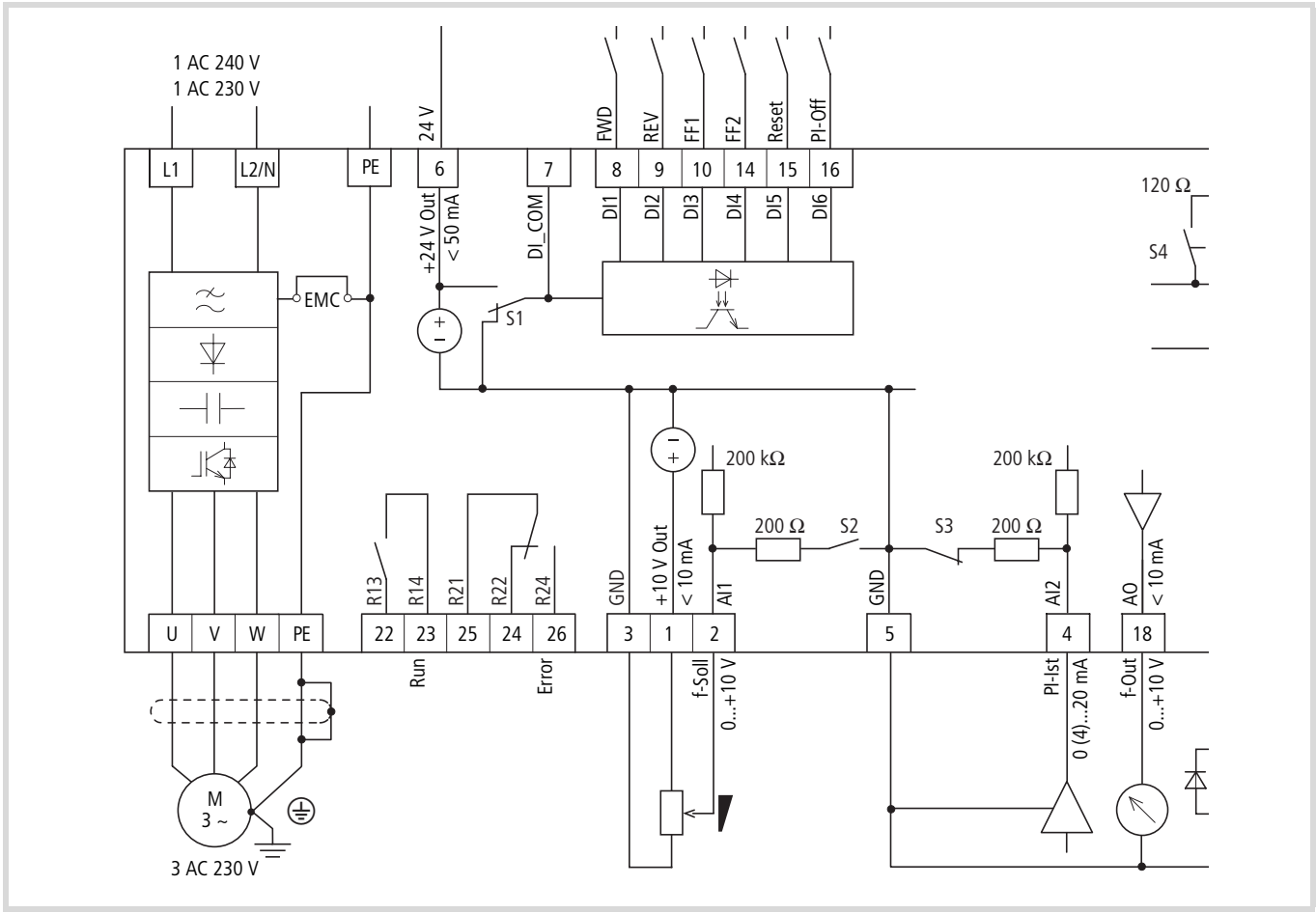


Figure 49: MMX12 block diagram

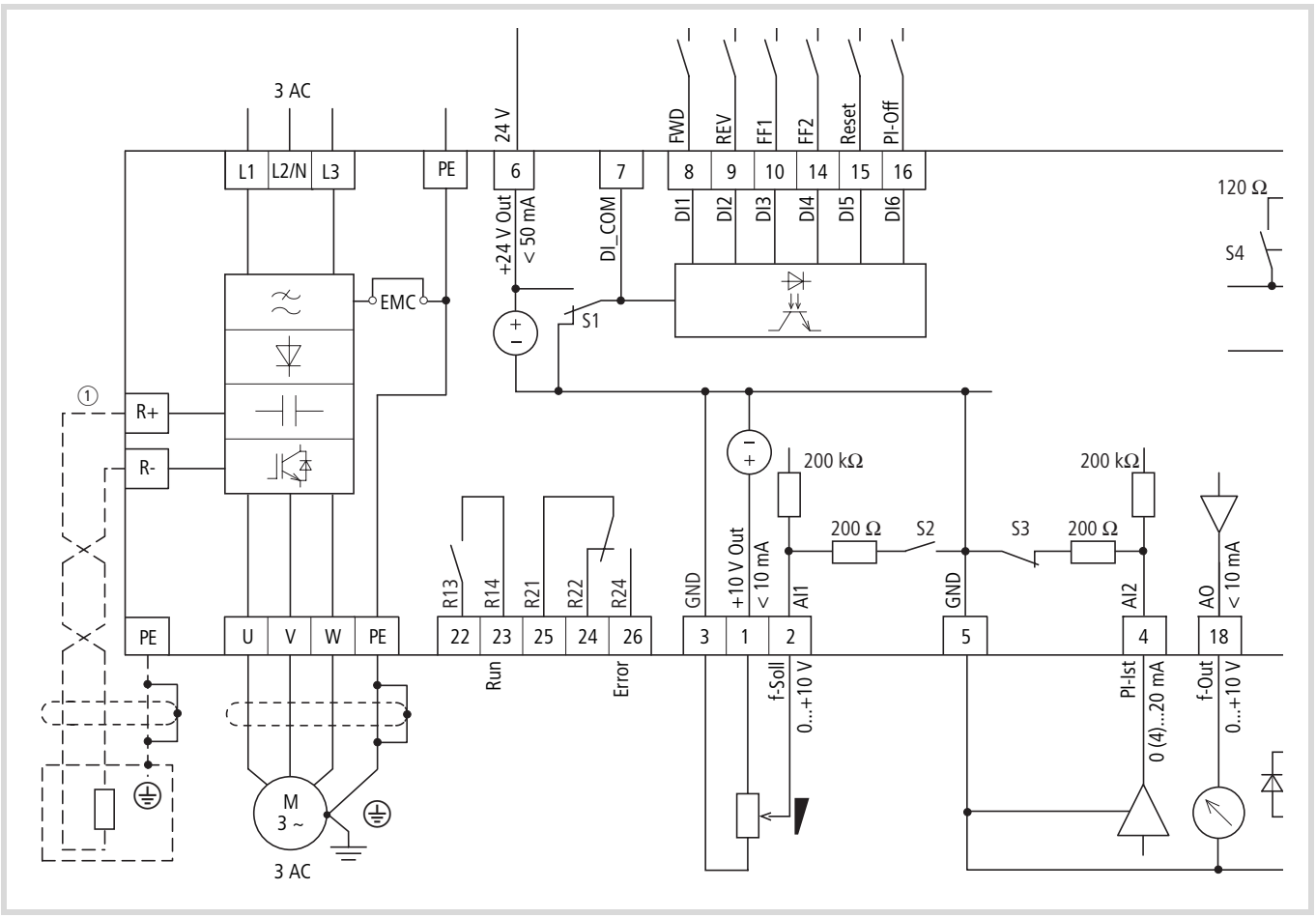


Figure 50: Block diagram MMX32 and MMX34

① Connection terminals R+ and R- for external braking resistance (optional), only with MMX34…4D3…, MMX34…5D6…, MMX34…7D6…, MMX34…9D0, MMX34…012… and MMX34…014….

Insulation testing

The adjustable frequency drive of the M-Max series are tested, delivered and require no additional testing.

Caution!

On the control signal and the connection terminals of the adjustable frequency drive, no leakage resistance tests are to be performed with an insulation tester.

Warning!
Wait at least 5 minutes after switching the supply voltage off before you disconnect a connection on the connection terminals (L1, L2/N, L3, U/T1, V/T2, W/T3, R+, R-) of the adjustable frequency drive.

If insulation testing is required in the power circuit of the PDS, you must consider the following measures.

Testing the motor cable insulation
Disconnect the motor cable from the connection terminals U/T1, V/T2 and W/T3 of the adjustable frequency drive and from the motor (U, V, W). Measure the insulation resistance of the motor cable between the individual phase conductors and between the phase conductor and the grounding conductor.

The insulation resistance must be greater than 1 MΩ.

Testing the mains cable insulation
Disconnect the power cable from the mains supply network and from the connection terminals L1, L2/N and L3 of the adjustable frequency drive. Measure the insulation resistance of the mains cable between the individual phase conductors and between each phase conductor and the grounding conductor.

The insulation resistance must be greater than 1 MΩ.

Testing the motor insulation
Disconnect the motor cable from the motor (U, V, W) and open the bridge circuits (star or delta) in the motor terminal box. Measure the insulation resistance of the individual motor windings. The measurement voltage must at least match the rated voltage of the motor but is not to exceed 1000 V.

The insulation resistance must be greater than 1 MΩ.

→ Consider the information from the motor manufacturer in testing the insulation resistance.

4 Operation

Checklist for commissioning

Before placing the adjustable frequency drive into operation, make sure to check the following (checklist):

No.	Activity	Note
1	Installation and wiring have been carried out in accordance with the corresponding installation instructions (→ IL0402001E).	
2	All wiring and line section leftovers, as well as all the tools used, have been removed from the adjustable frequency drive's proximity.	
3	All terminals in the power section and in the control section were tightened with the specified torque.	
4	The lines connected to the output terminals of the adjustable frequency drive (U/T1, V/T2, W/T3, R+, R-) are not short-circuited and are not connected to ground (PE).	
5	The adjustable frequency drive has been earthed properly (PE).	
6	All electrical terminals in the power section (L1, L2/N, L3, U/T1, V/T2, W/T3, R+, R- , PE) were implemented properly and were designed in line with the corresponding requirements.	
7	Each single phase of the supply voltage (L1, L2, L3) is protected with a fuse.	
8	The adjustable frequency drive and the motor have been adjusted for the corresponding line voltage (→ section "Rating and Rating Plate", page 9).	
9	The quality and volume of cooling air are in line with the environmental conditions required for the adjustable frequency drive.	
10	All connected control lines comply with the corresponding stop conditions (e.g., switch in OFF position and setpoint = zero).	
11	The parameters that were preset at the factory have been checked with the list of parameters (→ section "List of parameters", page 118).	
12	The effective direction of a coupled machine will allow the motor to start.	
13	All emergency switching off functions and safety functions are in an appropriate condition.	

Hazard warnings

Please observe the following notes.

Danger!
Commissioning is only to be completed by qualified technicians.

Danger!
Hazardous voltage!

The safety instructions on pages I and II must be followed.

Danger!
The components in the adjustable frequency drive's power section are energized if the supply voltage (line voltage) is connected. For instance: power terminals L1, L2/N, L3, R+, R-, U/T1, V/T2, W/T3.

The control signal terminals are isolated from the line power potential.

There can be a dangerous voltage on the relay terminals (22 to 26) even if the adjustable frequency drive is not being supplied with line voltage (e.g., integration of relay contacts in control systems with 230 V AC).

Danger!
The components in the adjustable frequency drive's power section remain energized up to five (5) minutes after the supply voltage has been switched off (intermediate circuit capacitor discharging time).

Pay attention to hazard warnings!

Danger!
Following a shutdown (fault, line voltage off), the motor can start automatically (when the supply voltage is switched back on) if the automatic restart function has been enabled.

(→ parameter P6.13)

Caution!
Any contactors and switching devices on the power side are not to be opened during motor operation. Inching operation using the power switch is not permitted.

Contactors and switching devices (repair and maintenance switches) on the motor side are never to be opened while the motor is in operation, if the adjustable frequency drive is set to speed control operating mode (sensorless vector, P11.8 = 1).

Inching operation of the motor with contactors and switching devices in the output of the adjustable frequency drive is not permitted.

Caution!
Make sure that there is no danger in starting the motor. Disconnect the driven machine if there is a danger in an incorrect operational status.

→ The START button is only functional if the KEYPAD operating mode is activated. The stop button is active in all operating modes.

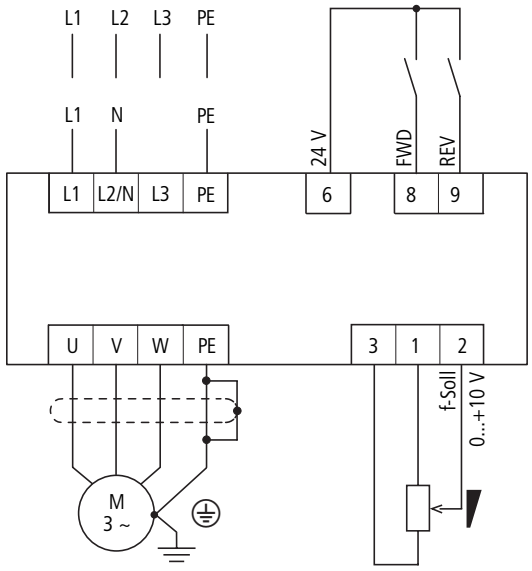
→ If motors are to be operated with frequencies higher than the standard 50 or 60 Hz, then these operating ranges must be approved by the motor manufacturer. The motors could be damaged otherwise.

Commissioning with control signal terminals (factory setting)

M-Max adjustable frequency drives are set in the factory and can be started directly via the control signal terminals by connecting the motor outputs allocated for the mains voltage (see connection example below).

→ You can skip this section if you want to set up the parameters directly for optimal operation of the adjustable frequency drive based on the motor data (rating plate) and the application.

The following shows a simplified connecting example of a connection with default settings.

Circuit example	Terminal	Designation	
	L1	Single-phase mains connection (MMX12)	Three-phase mains connection (MMX32, MMX34)
	L2/N		
	L3	-	
	PE	Ground connection	
	6	Control voltage +24 V (output, maximum 50 mA)	
	8	FWD, Start release clockwise rotating field	
	9	REV, Start release left rotating field	
	U	Connection for three-phase ac motor (three-phase motor)	
	V		
	W		
	PE		
	3	Setpoint value voltage +10 V (Output, maximum 10 mA)	
	1	Ground GND (0 V)	
	2	Frequency setpoint f-Set (Input 0 – +10 V)	

Connect the adjustable frequency drive according to the connection example for the simple commissioning with the specified factory setting (see connection example above).

→ If the connections for the setpoint value potentiometer cannot be clearly allocated with terminals 1, 2 and 3, you should set the potentiometer to about 50% before giving the start release (FWD/REV) for the first time.

By attaching the specified power supply to connection terminal L1 and L2/N (MMX12) or L1, L2/N and L3 (MMX32, MMX34), the LCD display is illuminated and all segments are shown briefly.

The adjustable frequency drive runs a self-test automatically when the power is applied.

The arrows ▲ in the top status line of the LCD display show the operating status:

- READY = proper operating status
- STOP = stop (no start command)

The arrows ▼ in the bottom status line show the controller commands. Actuation is done via the control signal terminals (I/O = Control Input/Output) in the factory setting.

The FWD mark (Forward) designates the basic rotational direction (phase sequence for a clockwise rotating field) on connection terminals U/T1, V/T2 and W/T3.

The operating data of the output frequency is shown in the LCD display in alternating sequence with M1.1 and 0.00 Hz.
The arrow ◄ in the left status line indicates the menu mode MON (Monitor = Operating data display).

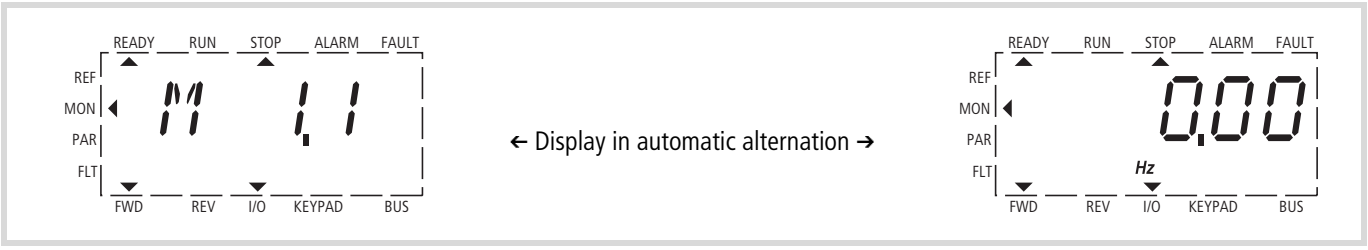


Figure 51: Operational data indicator (operational)

By actuating the OK button, you can set the display mode to stay on the value for the output frequency (0.00 Hz).

The start release is done by actuating one of the digital inputs with +24 V:

- Terminal 8: FWD = Clockwise rotating field (Forward Run)
- Terminal 9: REV = Counterclockwise rotating field (Reverse Run)

The control commands are interlocked (exclusive OR) and require a rising voltage edge.

The start release (FWD, REV) is shown in the top status line (LCD display) by the arrow ▲ switching from STOP to RUN.

The frequency is shown with a minus sign with a start release with a left rotating field (REV).

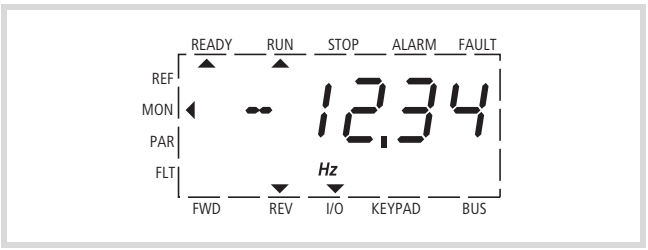


Figure 52: Operation (RUN) via control signal terminal (I/O) with left rotating field (REV) (e.g. -12.34 Hz)

You can now set the output frequency (0 – 60 Hz) and therefore the speed of the connected ac motor (0 – n_{motor}.) with the setpoint value potentiometer via terminal 2 (proportional voltage signal 0 – +10 V). The change in output frequency here is delayed based on the specified acceleration and deceleration ramps. In the factory settings, these times are set to 3 seconds.

The acceleration and deceleration ramps specify the time change for the output frequency: from zero to f_{max} (WE = 60 Hz) or from f_{max} back to zero.

figure 53 on page 57 shows a good example of the process, if the release signal (FWD/REV) is switched on and the maximum setpoint voltage (+10 V) is applied. The speed of the motor follows the output frequency depending on the load and moment of inertia (slip), from zero to n_{max}.

If the release signal (FWD, REV) is switched off during operation, the inverter is blocked immediately (STOP). The motor comes to an uncontrolled stop (see ① in figure 53, page 57).

The stop command can also be given via the STOP button on the operating unit. The STOP button is active in all operating modes.

A controlled run-down can be set using parameter P6.8 (STOP function) (P6.8 = 1).

The respective deceleration time is set in parameter P6.6. The acceleration time is set in parameter P6.5.

Information on settings and the description of the parameters used here is provided in section "Drives control (P6)", page 80.

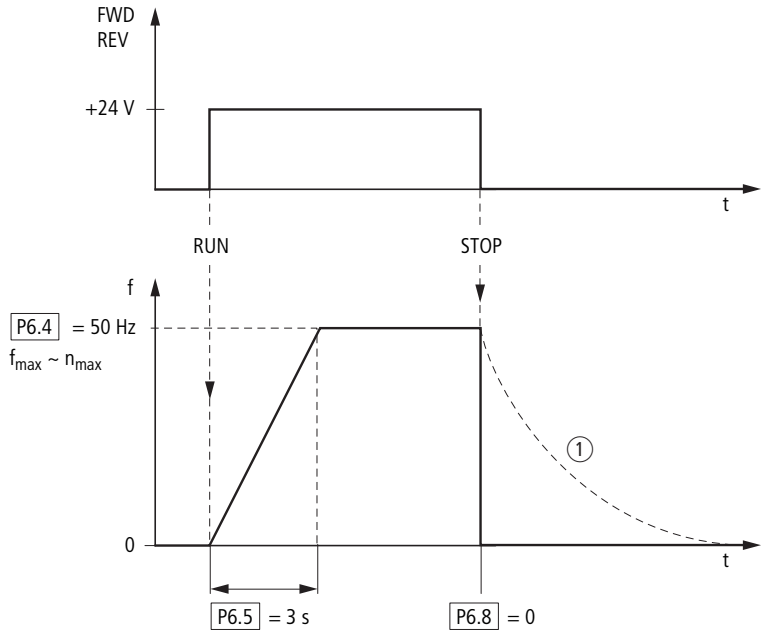


Figure 53: Start-Stop command with maximum setpoint value voltage, acceleration ramp 3 s

As an alternative (OR) to operation via control signal terminals, you can also operate the adjustable frequency drive without connecting the control signal terminals by simply switching the control level and the setpoint value input.

The following brief instructions indicate the required steps.

Brief Instructions

The brief instructions (see figure on page 57) is a graphic description of the few steps to motor-start.

By actuating the LOC/REM button, you can switch from the control signal terminal (I/O) to the operating unit (KEYPAD).

The start command can now be given via the START button on the operating unit.

The requested frequency setpoint value can be set in the REF menu. The selection is done with the BACK/ RESET button (the arrow on the left side of the LCD display flashes).

Use the arrow button ∧ to switch from menu level MON to REF (Reference, setpoint input).

Use the OK button to activate the setpoint input and display the frequency setpoint (0.00 Hz).
Actuate the OK button again until the number display flashes.

→ A change in the frequency setpoint value (REF) is only possible when the display is flashing. The activation is done with the OK button.

You can set the required frequency setpoint value with the two arrow buttons ∧ or ∨ (when the frequency display is flashing (0.00 Hz) (Frequency set value).

By actuating the arrow keys, you can change the value by one unit each time. Hold the arrow key down to change the value automatically (logarithmic increase).

By actuating the OK button again, the set value is saved, even if the supply voltage is switched off. The saved value is displayed continuously (without flashing).

→ In the factory settings, a direction change (FWD – REV) only occurs if the start button is pressed again at zero (0.00 Hz). An automatic rotational direction change (0.00 Hz continuous) can be set under parameter P6.14 = 1.

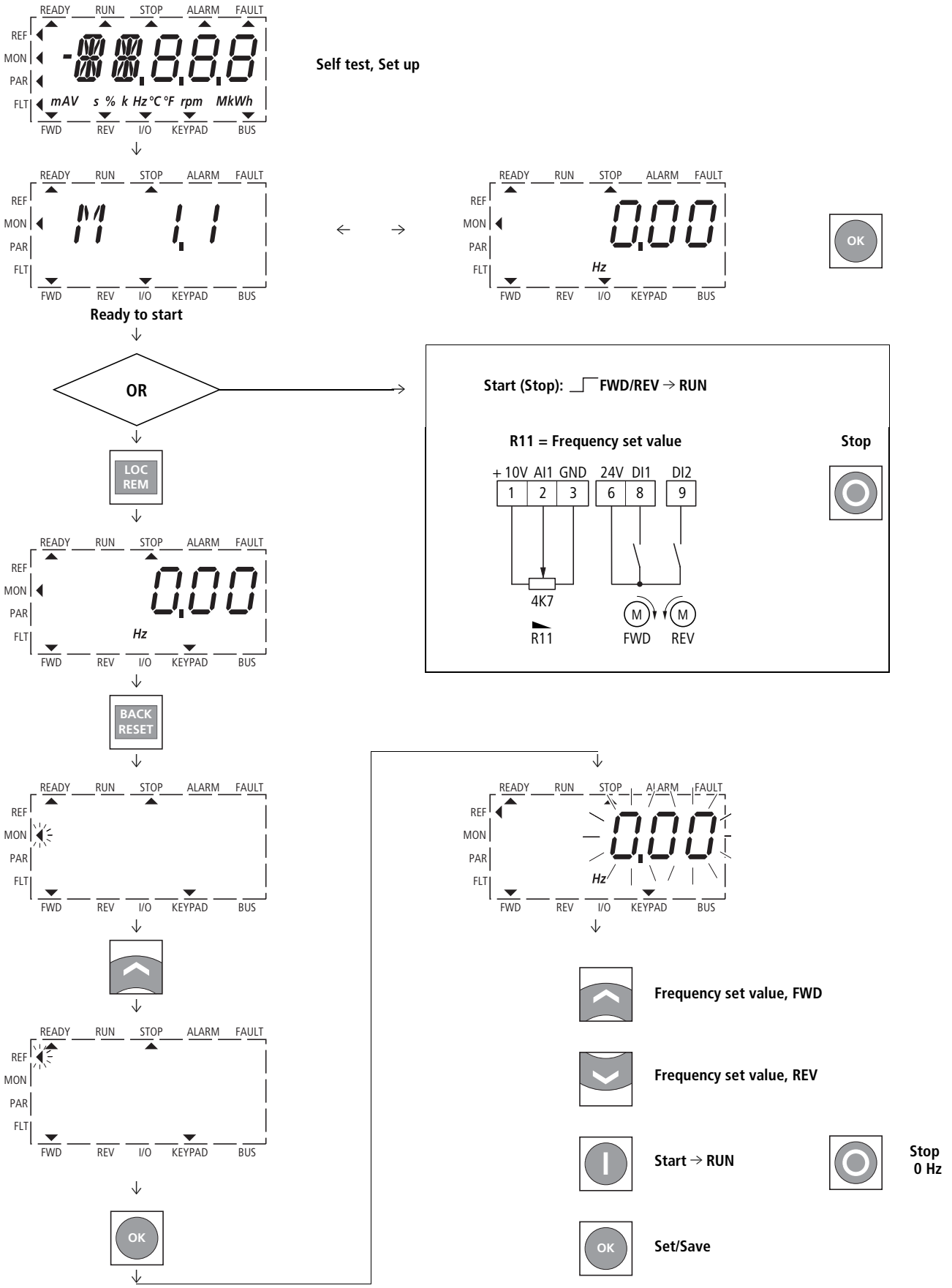
When a counter-clockwise field of rotation (REV) is selected, the frequency setpoint value is shown with a minus sign.

Self test, set up

By attaching the specified power supply to connection terminal L1 and L2/N (MMX12) or L1, L2/N and L3 (MMX32, MMX34), the LCD display is illuminated and all segments are shown briefly.

Ready to start

After a self-test, the operating data of the output frequency (M1.1 ← → 0.00 Hz) is shown in automatic alternating sequence.


READY RUN STOP ALARM FAULT
REF MON PAR FLT
mAV s % k Hz °C °F rpm MkWh
FWD REV I/O KEYPAD BUS
Self test, Set up
M 1.1
Ready to start
0.00
Hz
OK
OR
Start (Stop): FWD/REV → RUN
R11 = Frequency set value
Stop
+ 10V AI1 GND 24V DI1 DI2
1 2 3 6 8 9
4K7
R11
M M
FWD REV
LOC REM
BACK RESET
Frequency set value, FWD
Frequency set value, REV
Start → RUN
Stop 0 Hz
Set/Save

5 Error and Warning Messages

Introduction

The M-Max adjustable frequency drive have several internal monitoring functions. When deviations from the optimal operating status are detected, faults (FAULT) and warning messages (ALARM) are differentiated between.

Error messages

Faults can cause faulty functionality and technical defects. The inverter (adjustable frequency drive output) is automatically disabled if a fault is detected. The connected motor then runs down freely to a stop.

Error messages are shown on the display with an arrowhead ▲ under FAULT and with the error code F… (F1 = first fault, F2 = second fault, etc.).

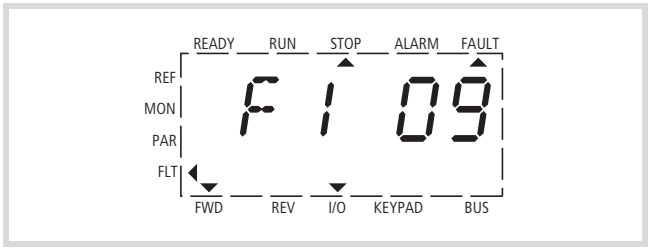


Figure 54: Error message example

Fault log (FLT)

The last nine faults can be called up and shown in succession in the fault log (FLT). If an active fault exists, the respective error number (e. g. F1 09 = undervoltage) is shown alternating with the main menu.

If you switch between faults, the error codes for active faults will flash. You can reset active faults by pressing the STOP button for one second. Faults that cannot be reset will continue to flash.

You can browse through the menu structure even if there are active faults. However, the error code will be shown again automatically if no button on the control unit is pressed. The operating hours, operating minutes, and operating seconds are shown on the value menu to a fault.

Alarm messages

A warning message warns of possible damages and indicates threatening faults, which can still be avoided however. For example, with an excessive increase in temperature.

Warning messages appear on the display with an arrow ▲ under ALARM and AL with the respective code number. The code numbers for faults and warning messages are identical.

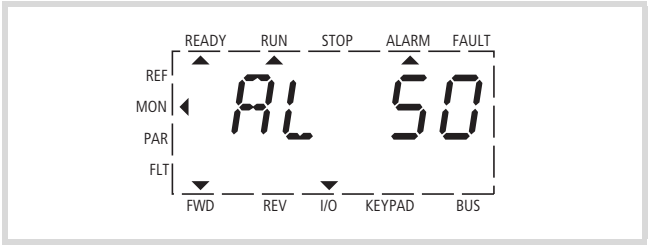


Figure 55: Example of an alarm message

→ If a warning message occurs, the adjustable frequency drive remains active (READY, RUN).

In the example (AL 50 = current setpoint signal 4–20 mA interrupted), the drive stops following a missing setpoint value. If no more measures are introduced because of the warning message (e. g. a shut-off), the drive can start again automatically in the example AL 50 when the current signal returns (e.g. a contact fault in the signal line).

The alarm message (AL) is displayed alternating with the active operational display value.

The following table 5 shows the error code, the possible causes and indicates corrective measures.

Table 5: List of fault messages (F) and warning messages (AL)

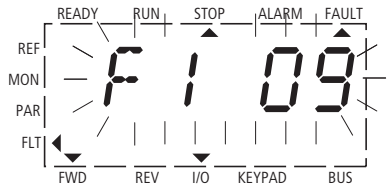
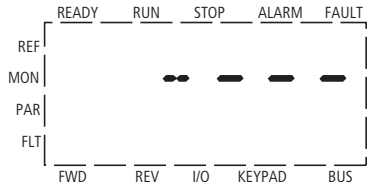
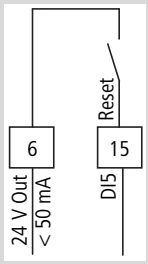
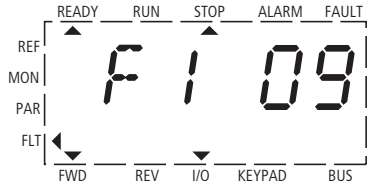
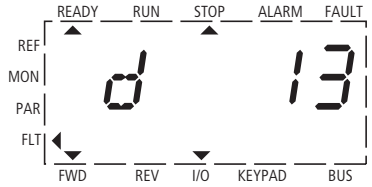
Display	Designation	Possible cause	Instructions
01	Overcurrent	• The adjustable frequency drive has detected an excessive current ($> 4 \times I_N$) in the motor cable. • Sudden load increase • Short circuit in motor cable • Inadequate motor	• Check the load • Check the motor size • Check the cable (→ parameter P6.6)
02	Overvoltage	• The DC intermediate circuit voltage has exceeded the internal safety limit. • The delay time is too short. • High overvoltage peaks in line power	Increase braking time
03	Ground fault	• An additional leakage current was detected when starting by means of a current measurement. • Insulation fault in the cables or in the motor	Check the motor cable and the motor
08	System fault	• Component fault • Malfunction	Reset the fault and restart If the fault occurs again, please contact your closest Eaton representative.
09	Undervoltage	The DC intermediate circuit voltage has exceeded the internal safety limit. Probable cause: • The supply voltage is too low • Internal device fault • Power failure	• If a brief power failure takes place, reset the fault and restart the adjustable frequency drive. • Check the supply voltage. If it is OK, there is an internal fault. If this is the case, please contact your closest Eaton representative.
13	Under-temperature	The IGBT switch temperature is below -10 °C	Check the ambient temperature
14	Overtemperature	The IGBT switch temperature is above 120 °C. An excessive temperature warning is issued if the IGBT switch temperature goes above 110 °C.	• Make sure that there is an unobstructed flow of cooling air • Check the ambient temperature • Make sure that the switching frequency is not too high in relation to the ambient temperature and to the motor load
15	Motor blocked	The motor blocking protection mechanism has been triggered.	Check the motor
16	Motor over-temperature	The adjustable frequency drive's motor temperature model has detected motor overheating. The motor is overloaded.	Decrease the motor load If the motor is not overloaded, check the temperature model parameter.
22	EEPROM checksum error	• Error when storing parameters • Malfunction • Component fault • Error in the microprocessor monitoring	Please contact your closest Eaton representative.
25	Watchdog	Error in microprocessor monitoring • Malfunction • Component fault	Reset the fault and restart If the fault occurs again, please contact your closest Eaton representative.
34	Internal communication error	Environment interferences or faulty hardware	If the fault occurs again, please contact your closest Eaton representative.
35	Application error	The application is not working.	Please contact your closest Eaton representative.
50	4 mA fault (Analog input)	Selected signal range: 4 – 20 mA → parameter P2.1 • Current less than 4 mA. • Signal line broken detached • The signal source is faulty	Check the analog input's current source and circuit.
51	External fault	Error message on digital input. The digital input was programmed as an input for external error messages. The input is active.	• Check the programming and check the device indicated by the error message. • Check the cabling for the respective device as well.
53	Field bus error	The communication link between the master device and the drive's field bus has been interrupted.	Check the installation. If the installation is OK, please contact your closest Eaton representative.

Acknowledge fault (Reset)
By switching the supply voltage off, the error message (F, FAULT) is acknowledged and reset. The error code with the respective operating times (d = days, H = hours, M = minutes) remains stored (FLT).

→ If the fault log (FLT) is activated and you hold the STOP button pressed for five seconds in STOP status, the contents of the fault log will be deleted.

In the factory setting, you can also acknowledge the error with a 24-V-DC signal on terminal 15 (DI5 = Reset). The error code is not deleted in this case.

The following table shows the required operations for acknowledging an error message via the operating unit.

Operating unit element	Explanation
	F1 = Current fault message (flashing display) 09 = undervoltage (example)
  	Actuate the BACK/RESET button or terminal DI5 (Reset) to acknowledge the fault message. 
	The acknowledged fault message is displayed with READY and the failure code.
  	By actuating the OK button, the number of operating days (e.g.. d = 13 days) until this fault message is displayed. You can also show the respective hours (H) and minutes (M) of operation with the arrow button ∨ .
	You exit the fault log (FLT) with the BACK/RESET button. The arrow ◀ changes to level MON.
	Use the OK button to activate the operating data display now or select another menu level with the arrow keys ∧ or ∨.

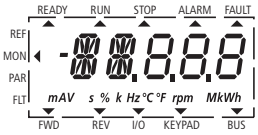
6 Parameters

Control unit

The following figure shows and indicates the elements of the M-Max's integrated control unit.

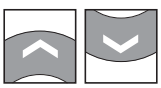
Figure 56: View: Control unit with LCD display, function keys, and interface

Tabelle 6: Control unit elements

Operating unit element	Explanation
	Backlit liquid crystal display (LCD) Plain text with alphanumeric characters
	Resets the error message (Reset). Activates the selection for the menu levels.
	Switch between the different control levels (I/O – KEYPAD – BUS)
	Select function and parameter Increase numerical value
	Confirm and activate selection (store) Lock display
	Select function and parameter Reduce numerical value
	Stops the running motor (active in any operating mode). When the menu level selection is active (arrow on left side flashes), the commissioning assistant can be started (hold the button pressed for 5 seconds).
	Motor start with selected direction of rotation (only active in KEYPAD control level)
	Interface for communication (Option: MMX-COM-PC)

→ The function of the STOP button is active in all operating modes, independent of the selected control position (I/O – KEYPAD –BUS).

→ Actuating the arrow keys causes the active value to increase or decrease the parameter number or the function by one unit.

 If you hold one of the two arrow keys pressed, the respective units increase or decrease automatically (logarithmic change).

Display unit

The following shows the display unit (LCD display with all display elements).

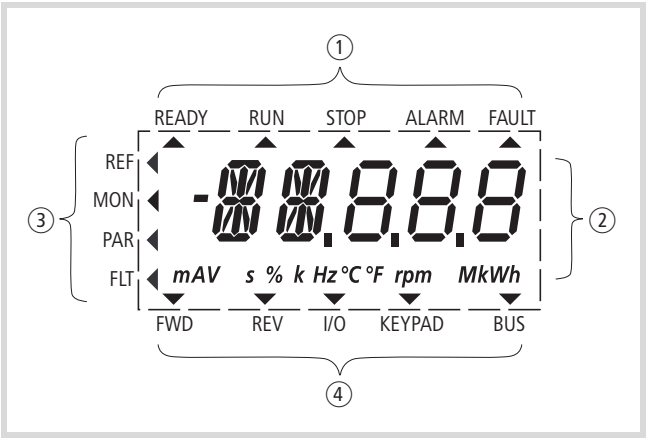


Figure 57: LCD display (areas)

The display unit consists of a backlit liquid crystal display (LCD). It is divided into four areas:

Tabelle 7: Areas of the LCD display

Area		Description
①	Status display	The arrowheads ▲ on the top border show information regarding the drive • READY = Ready to start • RUN = Operating notification • STOP = Stop, stop comman activated • ALARM = Alarm message activated • FAULT = The drive has been stopped due to an error message.
②	Plain text display	Two 14- and three 7-segment blocks for displaying: • AL = Alarm message • F = Error messages • M = Measurement value (operating data) • P = Parameter numbers • S = System parameter • - = Anticlockwise field of rotation (REV) The respective units of measurement are displayed in the bottom line.
③	Menu level	The arrow ◀ shows the selected main menu: • REF = Reference value input (Reference) • MON = Operational data indicator (Monitor) • PAR =Parameter levels • FLT = Fault log (Fault)
④	Control commands	The arrowhead ▼ points to the selected rotating field direction and the active control level: • FWD = Clockwise rotating field (Forward Run) • REV = Counterclockwise rotating field (Reverse Run) • I/O = Via control terminals (Input/Output) • KEYPAD = Via control unit • BUS = Via fieldbus (interface)

General information on menu navigation

By applying the specified supply voltage to the connection terminal L1 and L2/N (MMX12) or L1, L2/N and L3 (MMX32, MMX34), the adjustable frequency drive automatically runs the following functions:

- The lighting of the LCD display is switched on and all segments are actuated briefly.
- After the self-test, the top status line of the LCD display indicates that the device is ready to start and proper operation by an arrow ▲ under READY.
  The arrow under STOP indicates that there is no start command (FWD or REV).
- The arrow ▼ in the bottom status line shows the actuation via control signal terminals with the factory setting on I/O Control (Control Input/Output). The arrow over FWD (Forward) indicates the basic rotational direction (phase sequence for a clockwise rotating field) on the output terminals U/T1, V/T2 and W/T3).
- Display for the operating data M1.1 and 0.00 Hz (output frequency) in automatic alternating sequence. The arrow ◀ in the left-hand status line indicates menu level MON (Monitor = Operating data display).

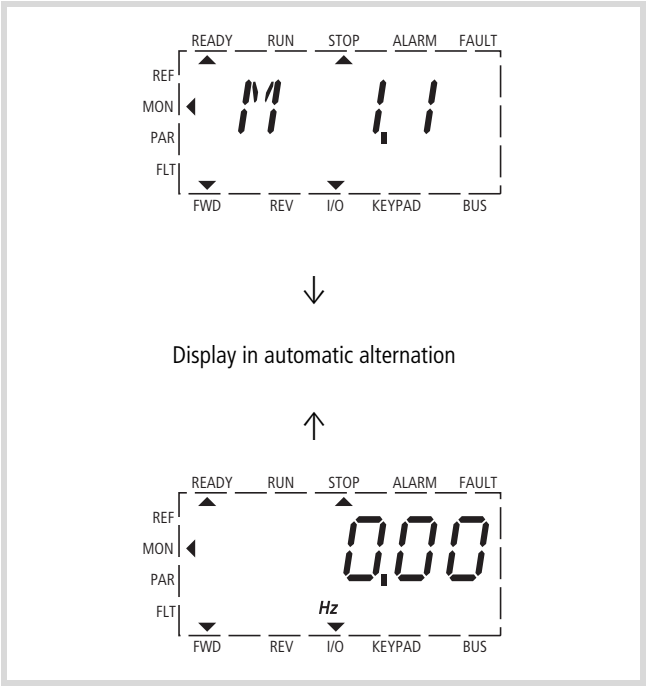


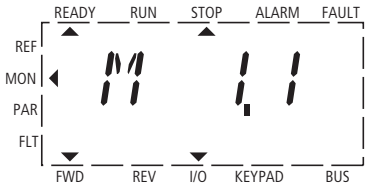
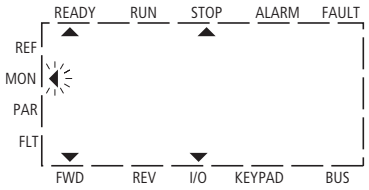
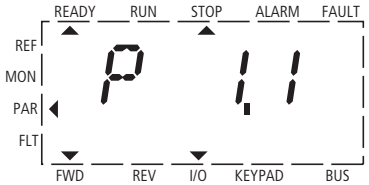
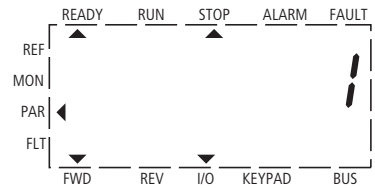
Figure 58: Operational data indicator (operational)

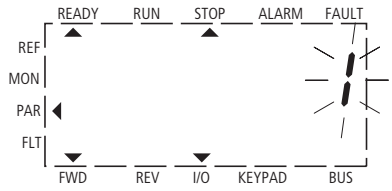
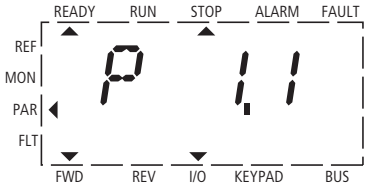
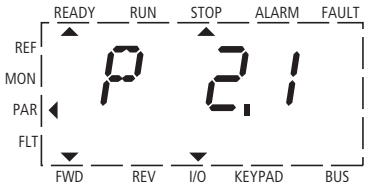
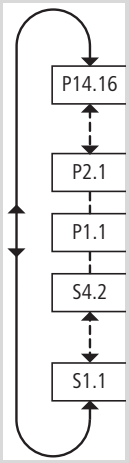
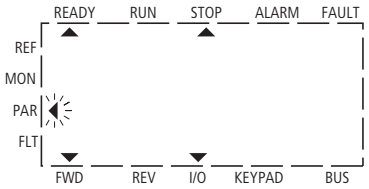
By actuating the OK button, you can set the alternating display mode to stay on the output frequency (0.00 Hz).

The adjustable frequency drive is ready for operation and can be started via the control signal terminal with the specified values from the factory settings when connecting the allocated motor output (see section "Commissioning with control signal terminals (factory setting)", page 55).

Setting parameters

The following table shows a good example of the general execution for selecting and setting parameters.

Sequence	Commands	Display	Description
0			Measured value 1.1 The display changes automatically with the value of the output frequency 0.00 Hz (at STOP).
1			By actuating the BACK/RESET button, you activate the menu level (arrow flashes).
			You can select the individual main menus with the two arrow keys (closed circuit): • REF = Reference value input (Reference) • MON = Operational data indicator (Monitor) • PAR =Parameter levels • FLT = Fault log (FAULT)
			Use the OK button to open the selected main menu.
2		 ↓ Display in automatic alternation ↑ 	The numerical first value is always shown from the selected main menu. Example: Main menu PAR, Parameter P1.1 The display automatically switches between the parameter number and the defined value.
			Use the OK button to activate the selected parameter. The value (1) flashes.

Sequence	Commands	Display	Description
3			If the parameter value is flashing, you can use the two arrow keys to change the value within the permitted range.
			The selected value is confirmed with the OK button. The display now changes automatically between the new value and the respective parameter number.
4			The other parameters in the main menu PAR can be selected with the two arrow keys (closed circuit, Example: Factory setting). 
5			By actuating the BACK/RESET button, you exit main menu PAR (arrow flashes, see sequence 1).

→ All settings are stored automatically by actuating the OK button.

→ Parameters marked in column "Access right RUN" with ✓ can be changed during operation (RUN mode).

Parameter menu (PAR)

You have access to all M-Max parameters in the parameter menu (OPAR) (see parameter list in the appendix on page 118).

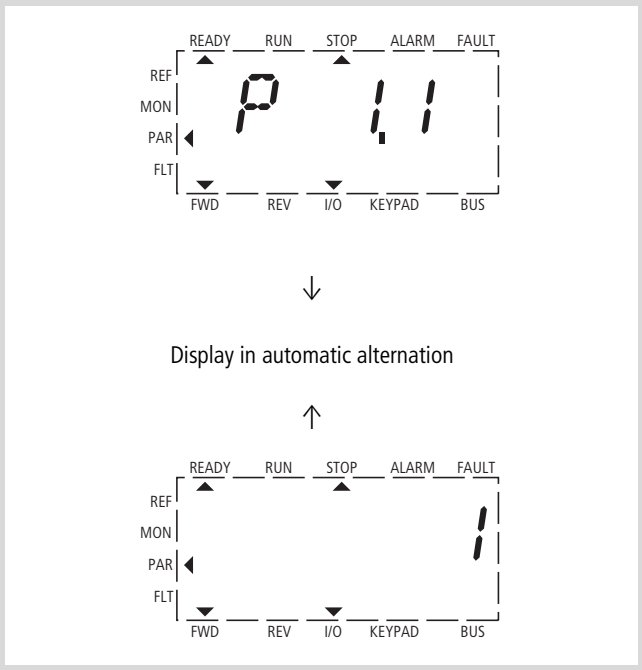


Figure 59: Parameter menu (P1.1 = 1, quick-configuration)

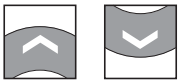
The parameter menu always starts with parameter P1.1.
In factory setting (delivery status or by activating S4.2 = 1), the quick-configuration (P1.1 = 1) is always activated to start with.

Quick configuration
In the quick-configuration, you are guided through all major settings that have to be made or that you should check for your application (see A in figure 60). The parameters that are called during the process are listed in table 8, page 72 in column "Basic (Standardoperation)".

→ The process is run from parameter to parameter. Returning is not possible here.

If you hold the OK button pressed, all parameters of the quick-configuration run through automatically up to the frequency display M1.1.

In the quick-configuration, the OK button activates the individual parameter values and then moves on to the next parameter. Every parameter always shows the value that is set in alternating sequence. By actuating the OK button again, you activate the value (value flashes).



By using both arrow keys ∧ and ∨, you can change only the values for the selected parameter in the quick-configuration.

The quick-configuration is completed with the automatic switch to the frequency display M1.1. By selecting the main menu PAR again, you can call up the parameters of the quick-configuration again if necessary.

Besides the parameters of the quick-configuration, system parameters S1.1 to S4.2 are also shown then (see section "System parameters in the quick-configuration", page 119).
P1.1 = 0 activates access to all parameters (free parameter definition, see B in figure 60).

This exits the quick-configuration and the guided setup with the quick-start assistant.

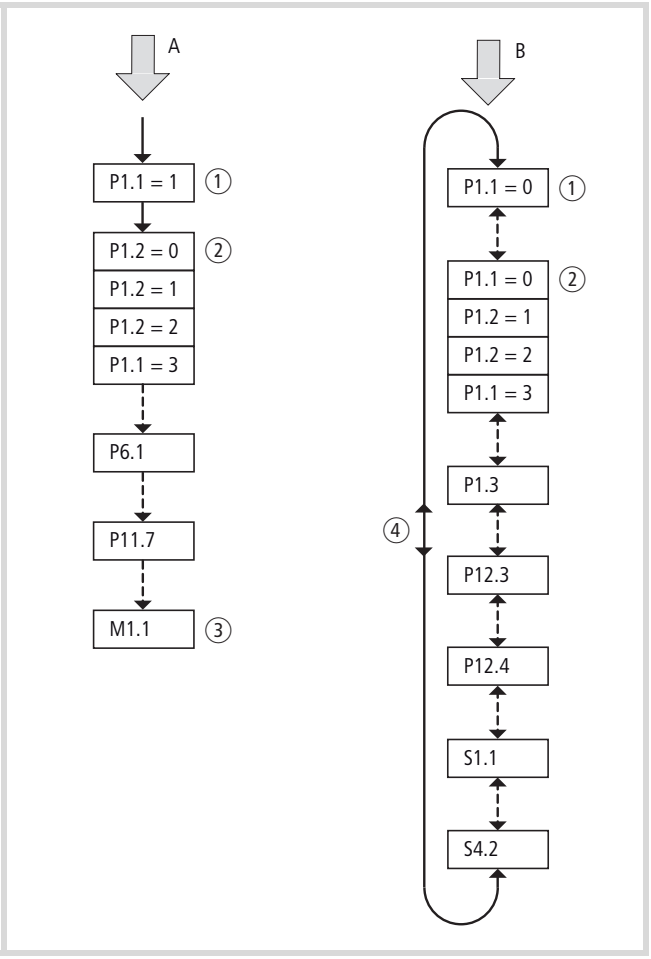


Figure 60: Schematic representation of parameter access

A Access and selected parameters with the quick-start assistant

B B free access to all parameters

① Parameter range selection
P1.1 = 1 (Factory setting)
The quick-start assistant guides you to the selected parameters (pre-defined parameter change)
P1.1 = 0 allows access to all parameters (free parameter selection).

② Selection of pre-defined parameter values for various applications (see table 8 on page 72)
P1.2 = 0: Basic, no preliminary setting
P1.2 = 1: Pump drive
P1.2 = 2: Fan drive
P1.2 = 3: Feed unit (high load)

③ Conclusion of the quick-configuration and automatic switch to the frequency display
Selecting the PAR menu level again allows the free selection of the selected parameters of the quick-configuration and the system parameter (S) now.

④ Free selection of all parameters (P1.1 = 0) with the two arrow keys ∧ and ∨ .

Parameter selection (P1)

In the parameter selection (P1), you are able to select between the factory defined quick-configuration
(P1.1 = 1) with reduced parameter set, all parameters
(P1.1 = 0) and the pre-defined application parameters (P1.2).

Setting the parameters with the quick-configuration and the application is run with a quick-start assistant (see section "Parameter menu (PAR)", page 69). In this case, each parameter executed must be processed serially until the frequency display M1.1.

Returning to a previous parameter is not possible. Only after the quick-start assistant (M1.1) is complete can you call up the parameter again and individually.

All major settings that have to be made or that you should check for your application are called up here. When the quick-start assistant is finished (Frequency display M1.1), you can call up each parameter individually again.

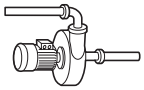
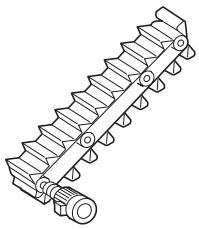
→ With P1.1 = 0 (all parameters) and P1.2 = 1, 2 or 3, you can link the predefined application values with all parameters.

→ Every single parameter value is set to factory settings every time that the application menu is activated.

PNU	ID	Access right RUN	Value	Description	Factory setting
P1.1	115	✓		Parameter ranges	1
			0	all Parameters All parameters are shown and can be changed.	
			1	Only quick configuration parameters Only the selected parameters of the quick configuration are shown and can be changed.	
P1.2	540			Applications	0
			0	Base	
			1	Pump drive	
			2	Fan drive	
			3	Hoisting device (high load)	

The following table shows the preset application parameters of parameter P1.2.

Tabelle 8: Predefined application parameters from parameter P1.2

Parameters	**Basic (Standard drive)**	 **Pump drive**	**Fan drive**	 **Feed unit (high load)**	**Designation**
P1.1	1 = Only quick configuration parameters	1 = Only quick configuration parameters	1 = Only quick configuration parameters	1 = Only quick configuration parameters	Parameter range
P1.2	0 = Basic	1 = Pump	2 = Fan	3 = Conveying	Application
P6.1	1 = Control signal terminals (I/O) (I/O)	1 = Control terminals (I/O)	1 = Control terminals (I/O)	1 = Control terminals (I/O)	Control level
P6.2	3 = AI1 (analog setpoint 1)	3 = AI1 (analog setpoint 1)	3 = AI1 (analog setpoint 1)	3 = AI1 (analog setpoint 1)	Set value definition (0 – 10 V) for terminal 2
P6.3	0.00 Hz	20.00 Hz	20.00 Hz	0.00 Hz	Minimum frequency
P6.4	50.00 Hz	50.00 Hz	50.00 Hz	50.00 Hz	Maximum frequency
P6.5	3.0 s	5.0 s	20.0 s	1.0 s	Acceleration time
P6.6	3.0 s	5.0 s	20.0 s	1.0 s	Deceleration time
P6.8	0 = Fee coasting	1 = Ramp (deceleration)	0 = Fee coasting	0 = Fee coasting	Stop function
P7.1	I_e	I_e	I_e	I_e	Motor rated operational current (= device rated operational current)[2)]
P7.3	1440 rpm	1440 rpm	1440 rpm	1440 rpm	Nominal motor speed (rpm)[2)]
P7.4	0.85	0.85	0.85	0.85	Motor power factor (cos v)[2)]
P7.5	230/400 V[1)]	230/400 V[1)]	230/400 V[1)]	230/400 V[1)]	Motor nominal voltage
P7.6	50.00 Hz	50.00 Hz	50.00 Hz	50.00 Hz	Motor nom. Frequency
P11.7	0 = Not enabled	0 = Not enabled	0 = Not enabled	1 = Enabled	Torque increase
M1.1	0.00 Hz	0.00 Hz	0.00 Hz	0.00 Hz	Output frequency

1) 230 V = MMX12…, MMX32…
400 V = MMX34…

2) Depends on performance variables

Analog input (P2)

In parameter group P2, you can adapt the analog inputs:

- AI1 (terminal 2): voltage signal 0 – +10 V.
  Factory setting: frequency setpoint value (f-Set) proportional to output frequency f-Out = 0 – f_{max} (P6.4)
- AI2 (terminal 4: current signal 4 – 20 mA.
  Factory setting: process variable 0 – 100 % as actual value for the PI controller (PI-Act)

Ground potential for the analog inputs (AI1, AI2) is GND (Terminals 3, 5, 7, 13).

→ The allocation of the analog inputs (AI1, AI2) can be set under parameter P6.2 (setpoint input) and P9.6 (PI controller, actual value).

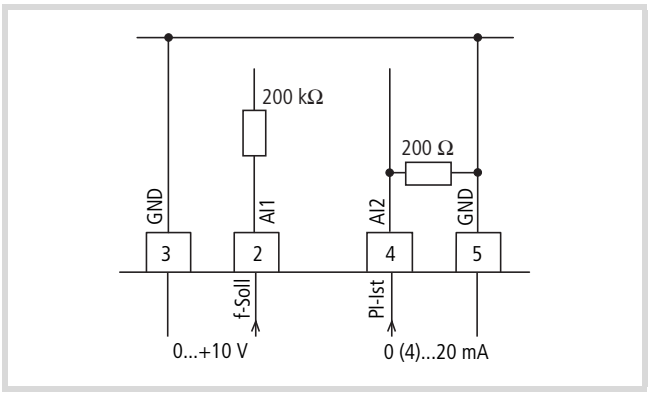


Figure 61: Analog inputs AI1 and AI2

PNU	ID	Access right RUN	Value	Description	Factory setting
P2.1	379	✓		AI1 signal range (Analog input)	0
			0	0 – +10 V, voltage signal	
			1	2 – +10 V, voltage signal (live-zero)	
P2.2	380	✓		AI1, minimum value	0.00
				Scaling (-100.00 % – 100.00 %) for the analog input voltage (AI1 = +10 V) in zero range (minimum response value). → section "Scaled value range (AI1, AI2)", page 74	
P2.3	381	✓		AI1, maximum value	100.00
				Scaling (-100.00 % – 100.00 %) of the analog input voltage (AI1 = +10 V) in limit value range (highest limit value). → section "Scaled value range (AI1, AI2)", page 74	
P2.4	378	✓		AI1, filter time constant	0.1
				0.0 no filter function 0.1 – 10.0 s, filter time constants for the analog input voltage (AI1 = +10 V) → section "Filter time constant", page 74	
P2.5	390	✓		AI2 Signal range (analog input)	3
			2	0 – 20 mA, current signal	
			3	4 – 20 mA, current signal (live-zero)	
P2.6	391	✓		AI2, minimum value	0.00
				Scaling (-100.00 % – 100.00 %) of the analog input current (AI2 = 20 mA) in zero range (minimum response value). → section "Scaled value range (AI1, AI2)", page 74	
P2.7	392	✓		AI2, maximum value	100.00
				Scaling (-100.00 – 100.00 %) of the analog input current (AI2 = 20 mA) in the limit value range (highest limit value). → section "Scaled value range (AI1, AI2)", page 74	
P2.8	389	✓		AI2, filter time constant	0.1
				0.0 no filter function 0.1 – 10.0 s filter time constant for the analog input current (AI2 = 20 mA) → section "Filter time constant", page 74	

Scaled value range (AI1, AI2)
The following graphics show a good example of the curve progress of the scaled and non-scaled input signals.

Example A
P2.2 (P2.6) = 30 %, P2.3 (P2.7 = 80 %)

The incoming, analog input signal 0 – +10 V (4 – 20 mA) is used here in the selected range from 30 to 80 %. This limited signal range is predefined as 0 to 100 % input signal (AI_{scal}):

– as frequency setpoint value from 0 – f_{max} (P6.4)
– as process variable from 0 – 100 % actual value for the PI controller

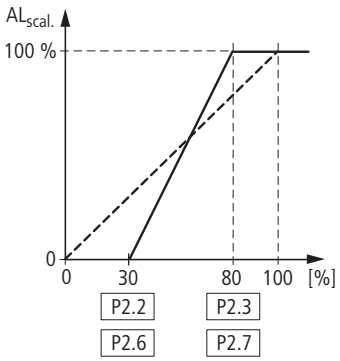


Figure 62: Example of scaled analog input signals

Example B
P2 (P2.6) = -30 %, P2.3 (P2.7) = 100 %

The incoming analog input signal 0 – +10 V (4 – 20 mA) is not evaluated in the selected range from 0 to 30 %. In relation to the 30 %-signal, a constant offset signal of (here) 23 % is predefined in this case. The scaled input signal (AI_{scal}) is therefore 23 to 100 %:

– as frequency setpoint value: 23 % f_{max} – f_{max} (P6.4)
– as process variable: 23 % – 100 % actual value for the PI controller

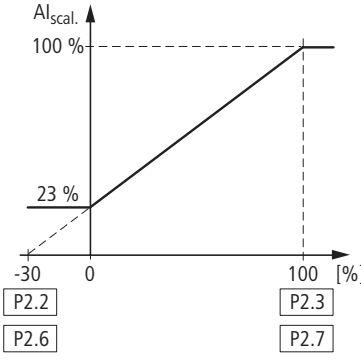


Figure 63: Example of scaled analog input signals with offset

Filter time constant
Faults in the incoming analog signal can be filtered out with the filter time constant.

The filter time constant is active at 0.1 seconds in the factory settings. Greater values can be set under parameters P2.4 (AI1) and P2.8 (AI2). The time value set here applies for 63 % of the maximum set value (+10 V, 20 mA).

→ Long filter times lead to a delay in the analog signal processing.

You can deactivate the filter time constant by setting value 0.0 under parameters P2.4 or P2.8.

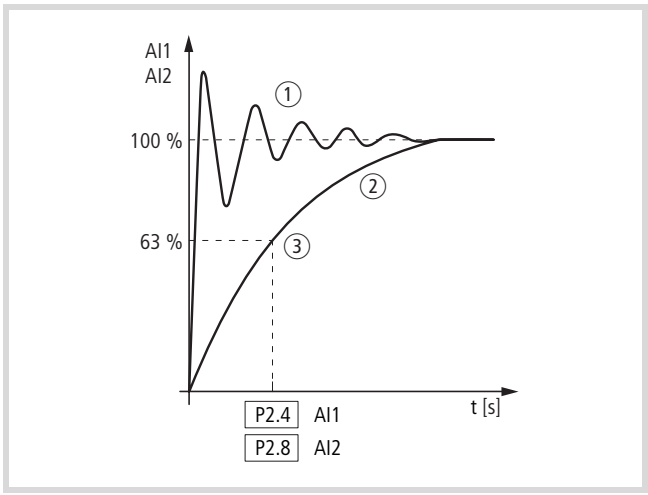


Figure 64: Filter time constant

① Analog signal with faults (unfiltered)
② Filtered analog signal
③ Filter time constant at 63 % of the set value

Digital input (P3)

In the parameter group P3, you can assign the digital inputs DI1 to DI6 with different functions.

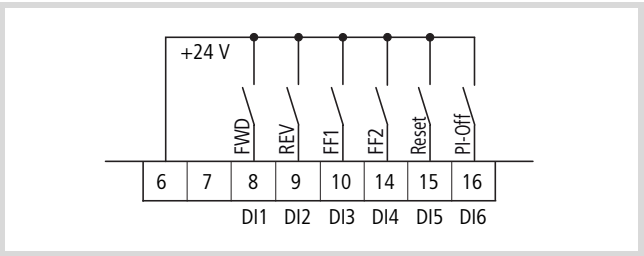


Figure 65: Digital inputs (factory setting)

→ The functions can be assigned multiple times. The assigned function is activated if the control signal terminal is actuated with +24 V (reference potential GND) (rising edge, wire-breakage-safe).

The operation of the M-Max via control signal terminals (I/O) is active with factory settings:

- DI1 (Terminal 8): FWD (Forward = Start release clockwise rotating field)
- DI2 (Terminal 9): REV (Reverse = start release counter-clockwise rotating field)
- DI3 (Terminal 10): FF1 (Fixed frequency 1 = 10 Hz)
- DI4 (Terminal 14): FF2 (Fixed frequency 2 = 15 Hz)
- DI5 (Terminal 15): Reset (Error message ALARM acknowledge)
- DI6 (Terminal 16): PI-Off (Block PI controller)

→ The common actuation from terminal 10 (FF1) and terminal 14 (FF2) activates the fixed frequency FF3 (15 Hz) in the factory setting.

The operation via control signal terminals (I/O) can be activated with the button LOC/REM or via parameter P6.1 = 1 (control signal terminals).

PNU	ID	Access right RUN	Value	Description	Factory setting
P3.1	300	✓		Start-Stop-Logic (rising edge)	3
			0	DI1 (FWD), DI2 (REV), REAF REAF (Restart after Fault) = Restart after an error message Function same as P3.1 = 3 The automatic restart after an error message (FAULT) requires setting P6.13 = 1. The rising edge of the control voltage on terminal 8 (DI1) or terminal 9 (DI2) is not checked in this case.	
			1	DI1 (FWD) + DI2 = REV (see example A, page 74)	
			2	DI1 (Start pulse), DI2 (Stop pulse) Start- and Stop command via terminal 8 (DI1 = Start) and 9 (DI2 = Stop) with a brief pulse (+24 V). (see example B, page 74)	
			3	DI1 (FWD), DI2 (REV) DI1 (Terminal 8) starts the drive with a clockwise rotating field (FWD) and DI2 (Terminal 9) with counter-clockwise rotating field (REV). Both control commands are interlocked (Exclusive OR).	
P3.2	403	✓		Start signal 1	1
			0	Deactivated	
			1	Activated via terminal 8 (DI1)	
			2	Activated via terminal 9 (DI2)	
			3	Activated via terminal 10 (DI3)	
			4	Activated via terminal 14 (DI4)	
			5	Activated via terminal 15 (DI5)	
			6	Activated via terminal 16 (DI6)	
P3.3	404	✓		Start signal 2	2
				Allocation of the function to control signal terminals same as P3.2	
P3.4	412	✓		Reversing (changes the direction of the field of rotation from FWD to REV.)	0
				Allocation of the function to control signal terminals same as P3.2	

<table>
<tr><th>PNU</th><th>ID</th><th>Access right RUN</th><th>Value</th><th>Description</th><th>Factory setting</th></tr>
<tr><td>P3.5</td><td>405</td><td>✓</td><td></td><td>External fault (High-Signal)
Allocation of the function to control signal terminals same as P3.2
Error message when applying +24 V to the assigned control signal terminal (DI1 to DI6).</td><td>0</td></tr>
<tr><td>P3.6</td><td>406</td><td>✓</td><td></td><td>External fault (Low-Signal)
Allocation of the function to control signal terminals same as P3.2
Error message when switching off or interrupting (wire-breakage-safe) the applied control voltage (+24 V) from the assigned control signal terminal (DI1 to DI6).</td><td>0</td></tr>
<tr><td>P3.7</td><td>414</td><td>✓</td><td></td><td>Error acknowledgment (Reset)
Allocation of the function to control signal terminals same as P3.2
Acknowledges a displayed error message (Reset) when switching on +24 V on the assigned control signal terminal (DI1 to DI6).</td><td>5</td></tr>
<tr><td>P3.8</td><td>407</td><td>✓</td><td></td><td>Start enable
Allocation of the function to control signal terminals same as P3.2
Rotational direction-independent start release when switching on +24 V on the assigned control signal terminal (DI1 to DI6).</td><td>0</td></tr>
<tr><td>P3.9</td><td>419</td><td>✓</td><td></td><td>Fixed frequency B0
Allocation of the function to control signal terminals same as P3.2
The binary connection of three digital inputs enable calling seven fixed frequencies (eight fixed frequencies if parameter P6.2 = 0 is set).
The limitation of the fixed frequencies is done based on parameters P6.3 (minimum frequency) and P6.4 (maximum frequency).
The switch between the individual fixed frequencies is done with the acceleration time and deceleration times in P6.5 and P6.6.
<table>
<tr><th colspan="3">Input</th><th>Fixed frequency</th></tr>
<tr><td>B0</td><td>B1</td><td>B2</td><td>(Factory setting)</td></tr>
<tr><td></td><td></td><td></td><td>FF0, P10.1 = 5 Hz, only if P6.2 = 0</td></tr>
<tr><td>X</td><td></td><td></td><td>FF1, P10.2 = 10 Hz</td></tr>
<tr><td></td><td>X</td><td></td><td>FF2, P10.3 = 15 Hz</td></tr>
<tr><td>X</td><td>X</td><td></td><td>FF3, P10.4 = 20 Hz</td></tr>
<tr><td></td><td></td><td>X</td><td>FF4, P10.5 = 25 Hz</td></tr>
<tr><td>X</td><td></td><td>X</td><td>FF5, P10.6 = 30 Hz</td></tr>
<tr><td></td><td>X</td><td>X</td><td>FF6, P10.7 = 40 Hz</td></tr>
<tr><td>X</td><td>X</td><td>X</td><td>FF7, P10.8 = 50 Hz</td></tr>
</table></td><td>3</td></tr>
<tr><td>P3.10</td><td>420</td><td>✓</td><td></td><td>Fixed frequency B1
Allocation of the function to control signal terminals same as P3.2</td><td>4</td></tr>
<tr><td>P3.11</td><td>421</td><td>✓</td><td></td><td>Fixed frequency B2
Allocation of the function to control signal terminals same as P3.2</td><td>0</td></tr>
<tr><td>P3.12</td><td>1020</td><td>✓</td><td></td><td>Deactivate PI controller
Allocation of the function to control signal terminals same as P3.2
When switching on +24 V power, the PI controller is blocked via the assigned control signal terminal (DI1 to DI6).</td><td>6</td></tr>
</table>

Example A: P3.1 = 1 (P6.8 = 0)

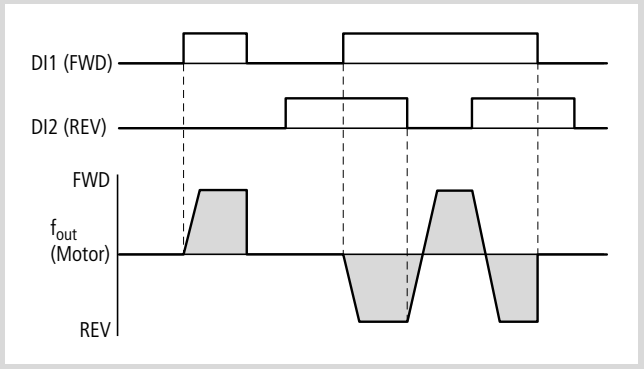


Figure 66: DI1 (FWD) + DI2 = REV

The start-release via terminal 8 (DI1) is always required for operation:

- Actuation on terminal 8 (DI1) = Start-release clockwise field of rotation (FWD)
- Actuation on terminal 8 (DI1) plus terminal 9 (DI2) = Start-release counter-clockwise field of rotation (REV)

The separate actuation on terminal 9 (DI2) does not allow start-release here.

Example B: P3.1 = 2

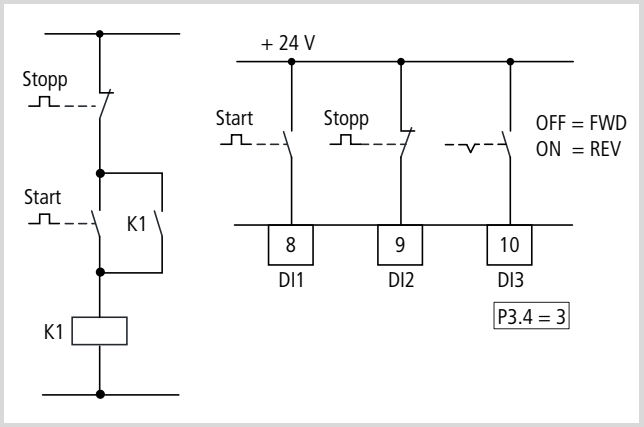


Figure 67: Example: Start stop impulse

Standard actuation for a drive with push-button switch (Normally open, Normally closed) and self-actuating

With parameter P3.1 = 2, this actuation can be replicated on terminals 8 (DI1) and 9 (DI2).

With parameter P3.4 = 3, a switch in directions for the field of rotation (FWD – REV) can be activated on terminal 10 (DI3) (reversing starter).

Analog output (P4)

An analog current signal from 4 - 20 mA is output on terminal 18. The signal is proportional to the output frequency f-Out = 0 – f_{max} (P6.4).

The maximum permitted external load resistor is 500 Ω (20 mA on 500 Ω ≙10 V, see figure 68)

Reference potential for the analog output (AO) is GND (Terminals 3, 5, 7, 13). The analog output works independently of the selected control level and operating mode.

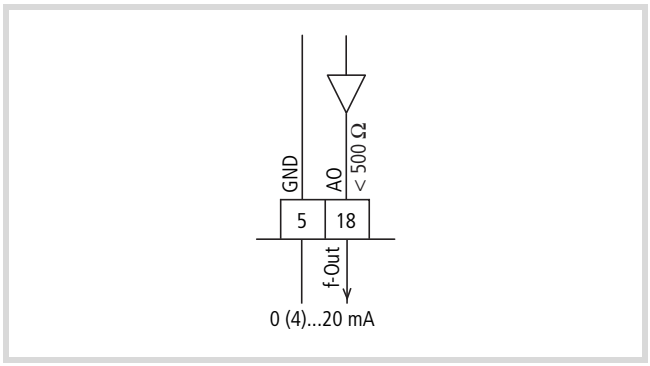


Figure 68: Analog output AO

PNU	ID	Access right RUN	Value	Description	Factory setting
P4.1	307	✓		AO signal (Analog Output)	1
			0	Deactivated (no current signal is output)	
			1	Output frequency f-Out = 0 – f_{max} (P6.4)	
			2	Output current I_2 = 0 – $I_{N\ Motor}$ (P7.1)	
			3	Torque M_N = 0 – 100 % (calculated value)	
			4	PI controller, output (0 – 100 %)	
P4.2	310	✓		AO, minimum value	1
			0	0 mA	
			1	4 mA (live-zero)	

→ The 4 mA output signal is not monitored by the adjustable frequency drive.

Digital output (P5)

The adjustable frequency drives of the M-Max series have three digital outputs in different specifications:

- Relay RO1: N/O R13-R14, Terminals 22 and 23,
- Relay RO2: C/O R21-R22 (N/C, Terminals 24 and 25)/ R22-R24 (N/O, Terminals 25 and 26),
- Transistor output DO: terminal 20 (open collector, switch to GND)

Notes on electrical connections are found on page 47 and 48.

The messages listed under P5.1 can be assigned multiple times. These are independent of the selected control level and operating mode.

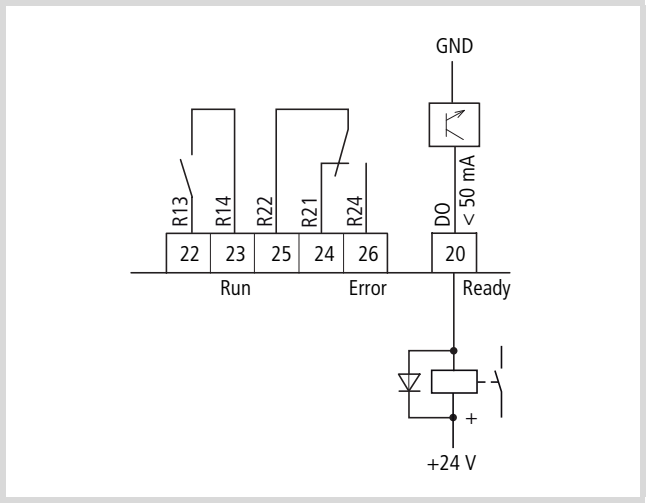


Figure 69: Digital outputs

PNU	ID	Access right RUN	Value	Description	Factory setting
P5.1	314	✓		RO1 Signal (Relay 1 Output)	2
			0	Not used	
			1	Ready for operation: The adjustable frequency drive is ready for operation.	
			2	Operation (RUN): The inverter of the adjustable frequency drive is released (FWD, REV).	
			3	Error message: An error was detected (FAULT).	
			4	Error message inverted: A detected error will not lead to switching off.	
			5	Warning (ALARM): A warning will not lead to switching off the adjustable frequency drive but indicates a certain event (see protective functions P8.1 to P8.6).	
			6	Reversing: The command for changing the direction of rotation (FWD ↔ REV) was given.	
			7	Setpoint value achieved: The output frequency (f-Out) has achieved the set frequency setpoint value.	
			8	Motor controller active: A limit value controller was activated (e.g. current limit, torque limit).	
P5.2	313	✓		RO2 Signal (Relay Output 2)	3
				Assignment of the function same as P5.1	
P5.3	312	✓		DO Signal (Digital Output)	1
				Assignment of the function same as P5.1	

Drives control (P6)

In this parameter group (P6), you can define the operating conditions for the adjustable frequency drive M-Max.

PNU	ID	Access right RUN	Value	Description	Factory setting
P6.1	125	✓		Select control level	1
			1	Control signal terminals (I/O) You can switch directly between I/O and KEYPAD with the LOC/ REM button	
			2	Control unit (KEYPAD) The LOC/REM button has no function here.	
			3	Interface (BUS) You can switch directly between BUS and KEYPAD with the LOC/ REM button.	

→ Selecting the control levels can be done directly with the LOC/REM button between the control levels selected in P6.1 and the operating unit.

The control level selected with parameter P6.1 or with the LOC/ REM button is shown on the bottom page in the LCD display (see figure 70).

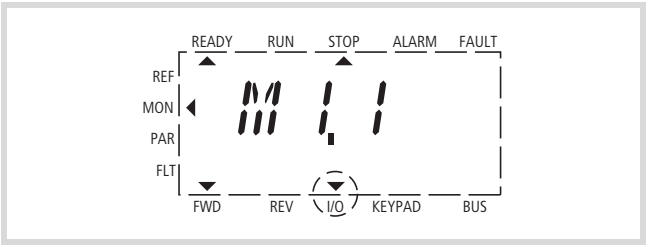
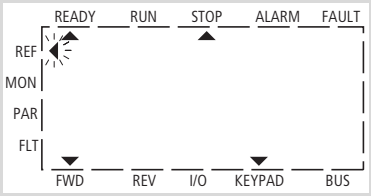


Figure 70: Example: Control level I/O activated

PNU	ID	Access right RUN	Value	Description	Factory setting
P6.2	117	✓		Setpoint input	3
			0	Fixed frequency (FF0) The value can be set in parameter P10.1.	
			1	Control unit For the setpoint input via the two arrow keys, the menu mode REF must be selected.  **Note:** The behavior for running set value zero through (stop or change in rotational direction) can be set in P6.14.	
			2	Interface (BUS) Setpoint input via Modbus RTU (control signal terminal A and B)	
			3	AI1 (analog setpoint 1) Voltage set value: 0 (2) – +10 V at control signal terminal 2 Scaling and filtering: P2.1 to P2.4	
			4	AI2 (analog setpoint 2) Current setpoint value: 0 (4) – 20 mA to control signal terminal 4 Scaling and filtering: P2.5 to P2.8	

PNU	ID	Access right RUN	Value	Description	Factory setting
P6.3	101	-		Minimum frequency	0.00
				0.00 – P6.4 [Hz]	
P6.4	102	-		Maximum frequency	50.00
				P6.3 – 320 Hz	
P6.5	103	-		Acceleration time	3.0
				0.1 – 3000 s (see figure 71 below)	
P6.6	104	-		Deceleration time	3.0
				0.1 – 3000 s (see figure 71 below)	

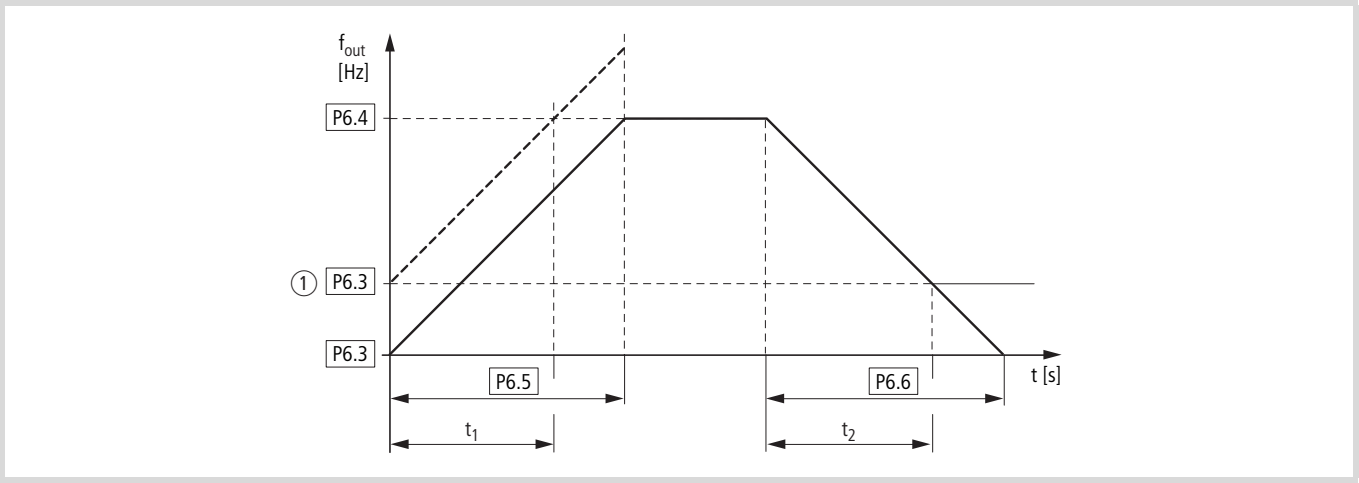


Figure 71: Acceleration and deceleration time
Reference points for the acceleration and deceleration times set in parameters P6.5 and P6.6 are always 0 Hz (P6.3) and the maximum output frequency is f_{max} (P6.4).
① When setting a minimum output frequency (P6.3 greater than 0 Hz), the acceleration and deceleration time of the drive is reduced to t_1 or t_2.

The values for the acceleration time t_1 and the deceleration time t_2 are calculated as follows:

$$t_1 = \frac{(P6.4 - P6.3) \times P6.5}{P6.4}$$

$$t_2 = \frac{(P6.4 - P6.3) \times P6.6}{P6.4}$$

→ The defined acceleration (P6.5) and deceleration times (P6.6) apply for all changes to the frequency setpoint value.

If the start-release (FWD, REV) is switched off, the output frequency (f_{Out}) is immediately set to zero. The motor runs down uncontrolled.

If a controlled run-down is requested (with value from P6.6), parameter P6.8 must be 1.

Starting friction and load inertia can lead to longer acceleration times for the drive than are set in P6.5. With large centrifugal masses or if driven by the load, the deceleration time of the drive can be greater than is set in P6.6.

PNU	ID	Access right RUN	Value	Description	Factory setting
P6.7	505	-		Start function	0
			0	Ramp (acceleration) The acceleration time with the value set under parameter P6.5	
			1	Flying restart circuit Starting on a running motor. By switching on a small current value, a small torque is created. With a frequency search (beginning with the maximum frequency P6.4), the correct rotational field frequency is determined. The output frequency is then adapted to the specified setpoint frequency based on the defined acceleration (P6.5) and deceleration (P6.6) times. You should use this function if the motor is already turning at the start command, with flow-machines (pumps, fans) and with short interruptions in input voltage for instance.	
P6.8	506	-		Stop function	0
			0	Free coasting The motor runs down uncontrolled after switching the start-release off (FWD/REV).	
			1	Ramp (deceleration) = dynamic braking Deceleration time with the value set under P6.6 If the energy that is fed back by the motor during the dynamic braking is too high, the deceleration time has to be extended. On devices with internal braking transistors, the excess energy can be dispelled through an external braking resistance (optional) (seesection "Braking (P12)", page 96)	
P6.9	500	-		Wave form, time-based S-form	0.0
			0.0	Linear acceleration and deceleration time based on P6.5 and P6.6	
			0.1 – 10.0 s	Time-graded transition to start and end of the acceleration ramp (P6.5) and deceleration ramp (P6.6). The time set here applies for both ramps (see figure 72).	

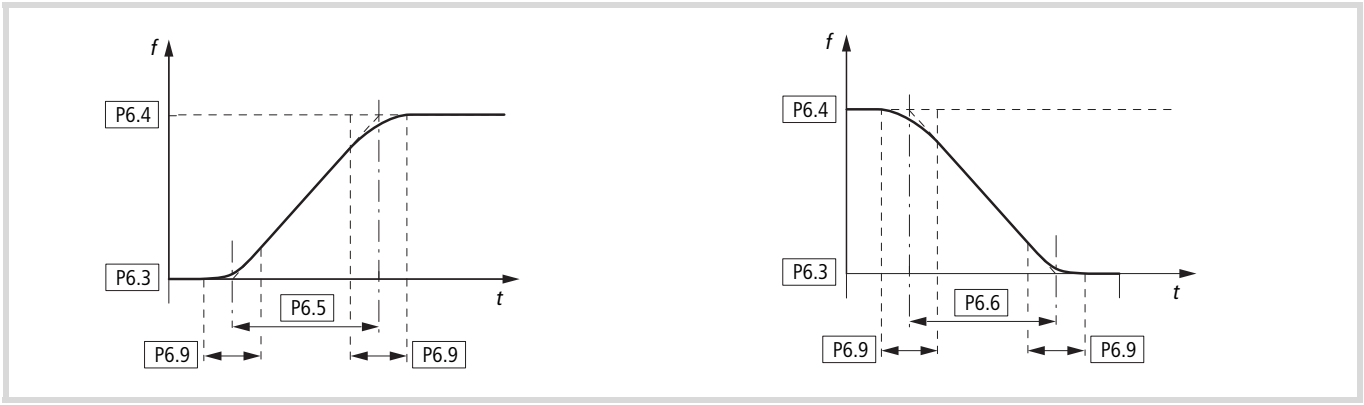
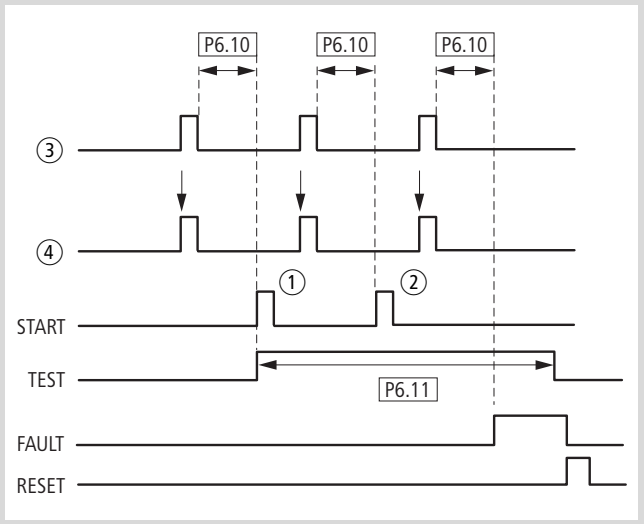


Figure 72: S-formed curve for acceleration and deceleration ramps

PNU	ID	Access right RUN	Value	Description	Factory setting
P6.10	717	-		Waiting time before an automatic restart	0.50
				0.10 – 10.00 s Active, if P6.13 = 1 Waiting time until automatic restart, after the detected error has disappeared	
P6.11	718	-		Testing period across three automatic restarts	30.00
				0.00 – 60.00 s Active, if P6.13 = 1 Timed monitoring of the automatic restart The test time begins with the first automatic restart. If more than three error messages occur during the testing period, fault status is activated. Otherwise, the error is acknowledged after the test time has elapsed and the test time is only started again with the next error.	
P6.12	719	-		Start function with automatic restart	0
			0	Ramp	
			1	Flying restart circuit	
			2	Based on P6.5 (acceleration ramp)	
P6.13	731	-		Automatic restart after an error message	0
			0	Not active	
			1	Active, activates function REAF (see P3.1 = 0, page 75).	
P6.14	1600	✓		Stop on direction change wehn REF crosses 0Hz Setpoint input operating unit (UP - STOP - DOWN) Setpoint input, if P6.2 = 1 and menu level REF is active	1
			0	Changes the direction of rotation (FWD ↔ REV) when set value of zero passes through.	
			1	Stops the drive upon setpoint input zero and requests a new actuation of the start button.	



① First automatic restart
② Second automatic restart
③ Shut-off when error detected
④ Motor stop signal

TEST = monitored test time
FAULT = shut-off when error message occurs
RESET = reset error message (FAULT)

Figure 73: Automatic restart after error message (two start attempts)

Motor (P7)

For optimal operation, you should enter the enter the ratings plate information for the motor here. This information makes up the base values for the motor controller (electrical reproduction, see section "V/Hz-characteristic curve (P11)", page 93).

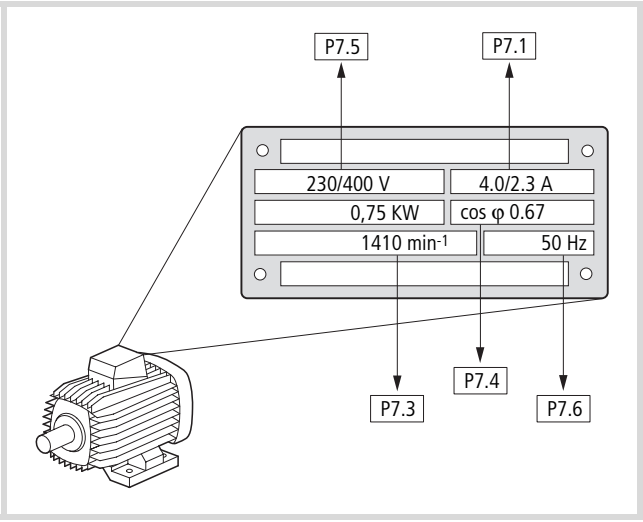


Figure 74: Motor parameters from ratings plate

→ The motor data is set to the rated operation data for the adjustable frequency drive and depends on the performance variables in factory settings ([1)]).

Switching type for stator windings of the motor

When selecting the rating data, take the dependency of the type of switching on the strength of the feeding mains voltage into account:

- 230 V (P7.5) → delta circuit → P7.1 = 4 A
- 400 V (P7.5) → Star connection → P7.1 = 2.3 A

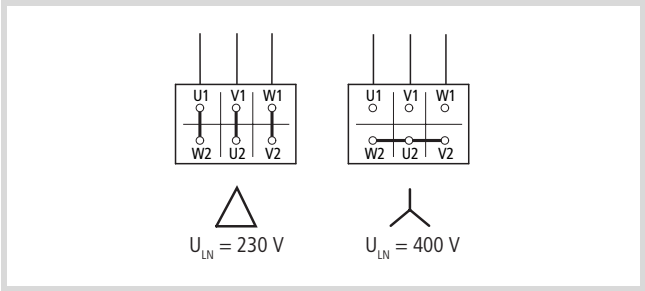


Figure 75: Circuits (delta, star)

Example

Single-phase connection for adjustable frequency drive MMX12AA4D8… on a mains voltage of 230 V. The stator winding of the motor is a delta circuit (motor rated operation current 4 A in accordance with the rating plate in figure 74). See [1)] in the factory settings.

Required changes for the electrical reproduction for the motor: P7.1 = 4.0, P7.3 = 1410, P7.4 = 0.67

PNU	ID	Access right RUN	Value	Description	Factory setting
P7.1	113	-		Motor nominal current Setting range: 0.2 × I_e – 1.5 × I_e [A] I_e = adjustable frequency drive's rated current (⟶ motor rating label)	4.8[1)]
P7.2	107	-		Current limitation Setting range: 0.2 × I_e – 2 × I_e [A] Factory setting: 1.1 × I_e	5.28[1)]
P7.3	112	-		Motor nominal speed Setting range: 300 – 20000 rpm (⟶ Motor ratings plate)	1440[1)]
P7.4	120	-		Motor power factor (cos φ) Setting range: 0.30 – 1.00 (⟶ Motor ratings plate)	0.85[1)]
P7.5	110	-		Motor nominal voltage Setting range: 180 – 500 V (⟶ Motor ratings plate) Pay attention to the supply voltage and the type of circuit in the stator winding!	230[1)]
P7.6	111	-		Motor nom. Frequency Setting range: 30 – 320 Hz (⟶ Motor ratings plate)	50.00[1)]

1) Example:
Values of factory setting MMX12AA4D8… in allocation to the ratings plate of the figure 74
Single-phase connection for adjustable frequency drive (MMX12…) on a mains voltage of 230 V
The stator winding of the motor is a delta circuit (Motor rated current 4 A).
Required changes to the parameter for the electrical reproduction of the motor: P7.1 = 4.0, P7.3 = 1410, P7.4 = 0.67

Protective functions (P8)

In parameter range P8, you can set the reaction of the adjustable frequency drive to external influences and increase the protection to the drive system (PDS):

- 0 = deactivated, no reaction
- 1 = Warning (e.g. Warning message AL 50)
- 2 = Error (stop mode after error message based on parameters P6.8, e.g. F…50)

The error - (FAULT) and warning messages (ALARM) are described in chapter 5.

PNU	ID	Access right RUN	Value	Description	Factory setting
P8.1	700	-		Response to 4mA reference fault	1
				When using the 4–20-mA setpoint value signal, a warning or an error message (F… 50) is output, if the signal drops under 3.0 mA or 5 seconds or under 0m6 mA for 0.5 seconds.	
			0	Deactivated	
			1	Warning (AL 50) **Note:** When the signal current is reestablished, the drive starts automatically as long as no shut-off has occurred because of the warning message.	
			2	Error (F… 50), stop function according to P6.8	
P8.2	727	-		Response to undervoltage error	2
				Under-voltage error in the intermediate circuit because of a low mains-side supply voltage, e.g. by connecting 230 V to a 400 V device or if a phase drops out	
			0	Deactivated	
			1	Warning (AL 09) **Note:** A start signal (START button, rising edge on the control terminals) must exist again for restarting.	
			2	Error (F… 09), stop function according to P6.8	
P8.3	703	-		Earth fault protection	2
				The earth-fault monitoring checks the currents in the motor phases and is continually active. It protects the adjustable frequency drive from ground faults with high currents.	
			0	Deactivated	
			1	Warning (AL 03)	
			2	Error (F… 03), stop function according to P6.8	
P8.4	709	-		Blocking protection mechanism	1
				The blocking protection is functions as an overload protection. It protects the motor from brief overloads (e. g. blocked motor shaft) and is set via parameter P7.2. **Note:** With long motor cable lengths and low motor power (poor efficiency cos φ), a higher (capacitive) motor current can flow causing early tripping. Solution: Motor reactor or sinus filter.	
			0	Deactivated	
			1	Warning (AL 15)	
			2	Error (F… 15), stop function according to P6.8	

PNU	ID	Access right RUN	Value	Description	Factory setting
P8.5	713	-		Underload protection The underload protection monitors the load on the connected motor in the range of 5 Hz to rated frequency (50/60 Hz). If the underload protection is activated, weak or torn drive belts or dry pumps can be detected and reported without additional sensors. This requires that the output current of the adjustable frequency drive be monitored. A message is output if less than 50 % of the rated value is achieved within 20 seconds. Under 5 Hz, the monitoring limit is at 10 %.	0
			0	Deactivated	
			1	Warning (AL 17)	
			2	Error (F…17), stop function according to P6.8	
P8.6	704	-		Motor temperature protection	2
				The motor temperature protection should protect the motor from overheating. It is based on a heat-calculation model and uses the motor current (P7.1) to determine the motor load (see figure 77, page 88)	
			0	Deactivated	
			1	Warning (AL 16)	
			2	Error (F… 16), stop function according to P6.8	
P8.7	705	-		Motor ambient temperature	40
				Setting range: -20 °C – +100 °C	
P8.8	706	-		Cooling factor at zero frequency	40.0
				Setting range: 0.0 – 150 % The cooling factor of the motor at zero frequency defines the ratio for cooling the motor at the rated frequency without an external fan at rated current (see figure 76, page 88).	
P8.9	707	-		Motor temperature time constant	45
				Setting range: 1 – 200 min The temperature time constant determines the time-span in which the heat calculation model achieves 63% of its end value. It depends on the design of the motor and is different from manufacturer to manufacturer. The larger the motor, the greater the time constant.	

Heat protection of the motor (P8.6 – P8.9)

→ The motor temperature protection is based on a calculated temperature model and uses the motor current set in parameter P7.1 to determine the motor load. It does not use a temperature measurement in the motor.

▽ **Caution!**
The calculated temperature model cannot protect the motor if the cooling flow to the motor is influenced, by a blocked air entry-way for instance.

The temperature model is based on the assumption that the motor achieves a winding temperature of 140 °C at rated speed and an ambient temperature of 40 °C, with 105 % rated load.

The cooling efficiency, without external cooling, is a function of the speed (corresponding with the output frequency of the adjustable frequency drive). When the motor is stationary (zero frequency), heat is also dissipated through the housing surface.

When the motor is under a great load, the current required by the motor can be higher than the rated operational current. The current provided by the adjustable frequency drive can be higher than the rated operational current of the motor. If the load requires this much current, there is a danger of a thermal overload. This is especially the case at lower frequencies (< 25 Hz). Here, the cooling effect (speed of the motor fan) and the load rating of the motor (see data sheet of the motor) are reduced similarly with lower frequencies. On motors that are equipped with an external fan, there is less of a load reduction at lower speeds.

With parameters P8.6 to P8.9, a motor temperature protection can be set for the adjustable frequency drive M-Max which protects the motor from overheating. The temperature protection is calculated.
A direct temperature measuring in the windings of the motor (see thermistor protection) offers great protection.

The reaction of the adjustable frequency drive M-Max on a determined thermal overload can be set via parameter P8.6. With parameter P8.8, you can set the cooling power (P_{Cool}) on the motor with zero frequency (standstill). Note the information of the motor manufacturer in this case.
Possible adjustment values are 0 to 150 % of the cooling power at rated frequency f_N (see ratings plate of the motor = P7.6).

→ If the protection function is deactivated (P8.6 = 0), the temperature model of the motor is reset to zero.

The thermal current I_{th} corresponds with the load current at maximum thermal loading on the motor. In continuous operation, at rated frequency (f_N = P7.6) and rated loading, the value of I_{th} corresponds with the rated current of the motor (see ratings plate of the motor = P7.1).

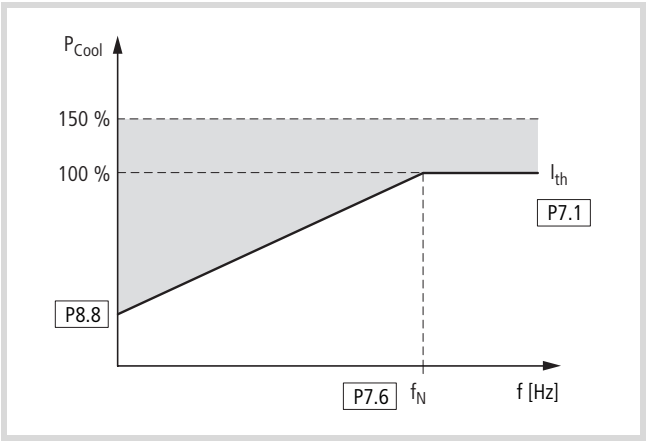


Figure 76: Motor cooling power

The time constant for the motor temperature (P8.9) defines how long it takes until the temperature has achieved 63% of its end value in the motor. In practice, this temperature time is constant depending on the type and design of the motor. It varies between the different design sizes at the same shaft power and between the different motor manufacturers.

The larger the motor, the greater the time constant.
The factory default value (P8.9 = 45 min) can be set in a range between 1 and 200 minutes. The recommended value is the doubled t_6-time of a motor. The t_6-time provides the time period in seconds, while a motor can be operated safely at six times the rated current (see the data sheet of the motor, manufacturer's information).

If the drive is stopped, the time constant is increased internally to three times the set parameter value (P8.9).

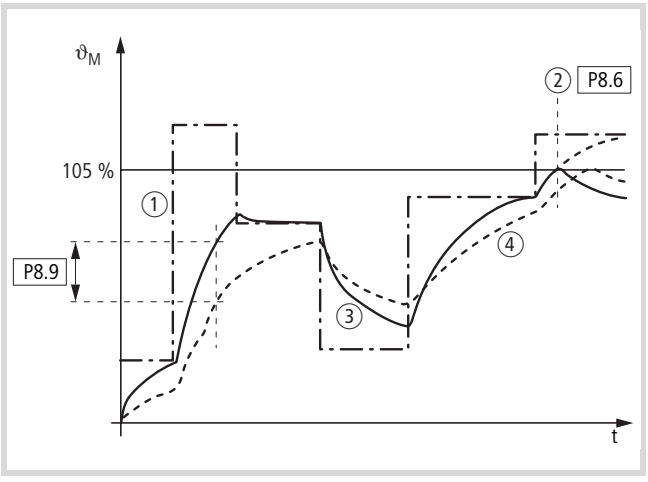


Figure 77: Calculation of motor temperature

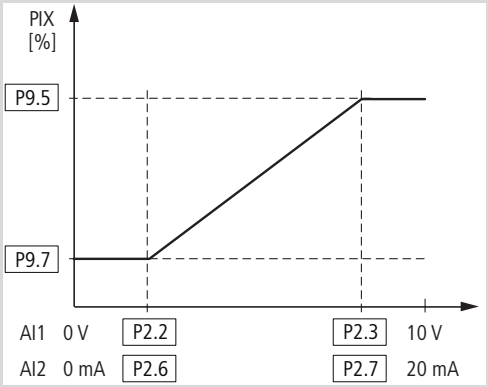
① Motor current I/I_T
② Trip value shut-off (error message) or warning according to P8.6
③ Calculated value for the motor temperature $Q = (I/I_T)^2 \times (1 - e^{-t/T})$
④ Motor temperature ϑ_M (example)
P8.9 = Motor temperature time constant (T)

PI controller (P9)

The PI controller integrated in the M-Max can be used for process controllers with returns. It must be activated under parameter P9.1 in this case.

You can select the source for the set value (w) under parameter P6.2, the input for the return for actual value (x) under P9.6. The continuous setpoint-/actual value comparison of the PI controller detects a deviation (e = w - x) in the process and eliminates this completely.

PNU	ID	Access right RUN	Value	Description	Factory setting
P9.1	163	✓		PI controller	0
			0	Deactivated	
			1	to drive control The PI controller internally generates the output frequency for the motor. By continually comparing the actual value (return signal from the process) with the setpoint value (speed specification for the process), the required motor frequency is determined by the PI controller. **Note:** The times for acceleration (P6.5) and deceleration (P6.6) should be set to zero here.	
			2	For external application The output signal of the PI controller does not influence the output frequency for the motor. The output signal of the PI controller can be used as an analog output signal (AO, Terminal 18, see P4.1) independent of the motor controller for the adjustable frequency drive.	
P9.2	118	✓		PI controller, P amplification	100.0
				0.0 – 1000 % Proportional gain factor of PI controller The control deviation (e = w - x ≠ 0) is multiplied with this factor. The factory default value of 100 % causes a change in the control output of 10 % with a system deviation of 10 %. **Note:** When the gain factor is too great, the controller oscillates.	
P9.3	119	✓		PI controller, I time constant	10.0
				0.00 – 320.0 s The control deviations are added up over time in the integral portion of the PI controller. The longer a control deviation exists, the greater the manipulated variable of the I controller. A value of one second set here changes the control output per second on the value (gain x deviation/second) influenced by the gain (P9.2). **Note:** If the time values are set too low, the sign change in the control deviation is prevented and therefore a comparison with zero.	
P9.4	167	✓		PI controller, setpoint (w) via control unit	0.0
				0.0 – 100.0 % Setpoint input for the PI controller via the operating unit. The setting is done with the selected parameter directly with the arrow keys ∧ and ∨.	
P9.5	332	✓		PI controller, setpoint source	0
			0	Control unit	
			1	Interface (BUS)	
			2	AI1 Terminal 2, Analog input 1: 0 (2) – +10 V Reference point GND: Terminals 3, 5, 7, 13	
			3	AI2 Terminal 4, Analog input 2: 0 (4) – 20 mA Reference point GND: Terminals 3, 5, 7, 13	

PNU	ID	Access right RUN	Value	Description	Factory setting
P9.6	334	✓		PI controller, actual value (x)	0
			0	Deactivated	
			1	AI1 Terminal 2, Analog input 1: 0 (2) – +10 V Reference point GND: Terminals 3, 5, 7, 13	
			2	AI2 Terminal 4, Analog input 2: 0 (4) – 20 mA Reference point GND: Terminals 3, 5, 7, 13	
P9.7	336	✓		PI controller, actual value limiting, minimum	0.0
				0.0 – 100.0 % The scaling on the analog input is done for a minimum value via parameter P2.2 or P2.6.	
P9.8	337	✓		PI controller, actual value limiting, maximum	100.0
			0	0.0 – 100.0 % The scaling for the analog input is done for the maximum value via parameter P2.3 or P2.7. 	
P9.9	340	✓		PI controller, Invert controller deviation	0
				e = w - x (actual value - reference value) e = System deviation w = Setpoint value (Reference input variable) x = Actual value (Controlled variable, Process variable)	
			0	No inversion with positive control deviation (+e) → PI output value is increased	
			1	Inversion with positive control deviation (+e) → PI output value is reduced	

Fixed frequency setpoint value (P10)

In this parameter group (P10), you can set eight different fixed frequency setpoint values (FF0 to FF7). The selection is binary coded through digital inputs DI1 to DI6 (see section "Digital input (P3)", page 75).

The fixed frequencies have the highest priority in comparison with all other setpoint values and can be called up at any time without a separate enable.

In the factory settings, the fixed frequencies FF1 = 10 Hz, FF2 = 15 Hz and FF3 = 20 Hz are called up via digital inputs DI3 (terminal 10) and DI4 (terminal 14).

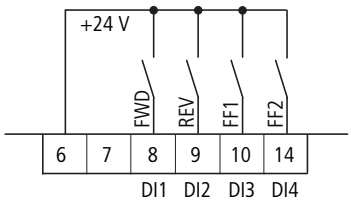


Figure 78: Fixed frequencies FF1, FF2 and FF3 (= FF1 + FF2)

→ The maximum permitted set value for a fixed frequency is limited by parameter P6.4 (maximum frequency). The minimum fixed frequency can be set using the value from P6.3 (minimum frequency).

The switch between the individual fixed frequencies is done with the acceleration and deceleration values set under P6.5 and P6.6. If release FWD or REV is shut off, the output frequency is blocked directly (uncontrolled run down). The drive has a controlled delay with P6.8 = 1 ①.

You can also allocate the fixed frequency with a function (see paramter group P3) and reduce the actuation to two terminals this way, with a feed unit for instance:

Terminal 8: FWD + FF1 = Transport under full load (e.g. 50 Hz)

Terminal 9: REV + FF2 = fast, unloaded return (e.g. 70 Hz)

→ The fixed frequency values can be changed during operation (RUN).

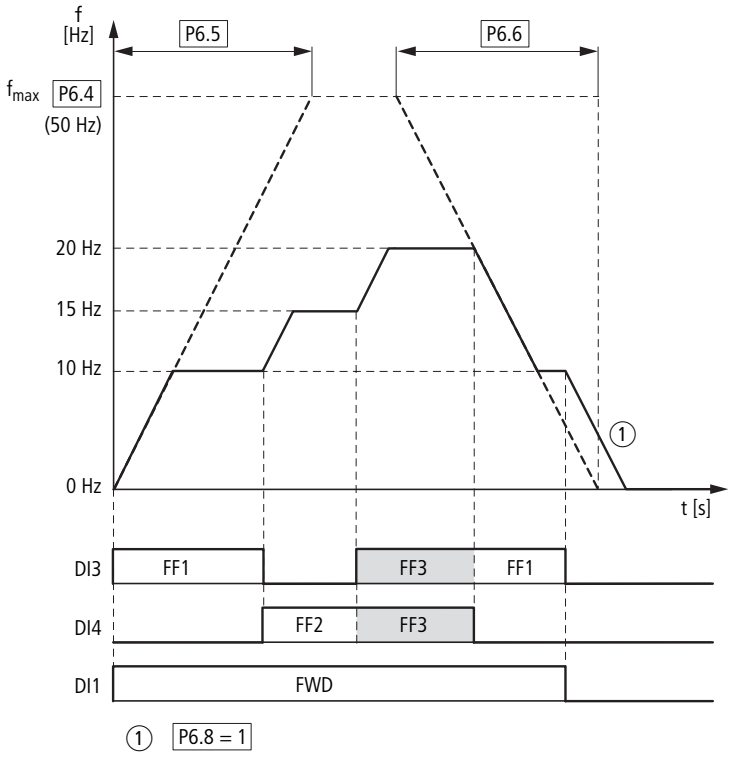


Figure 79: Example: Activation of the fixed frequencies to the factory setting

PNU	ID	Access right RUN	Value	Description	Factory setting
P10.1	124	✓		Fixed frequency FF0 0.00 Hz up to the maximum frequency value (P6.4) This value is only active if for the setpoint input has been set the parameter P6.2 = 0.	5.00
P10.2	105	✓		Fixed frequency FF1 0.00 Hz up to the maximum frequency value (P6.4) This value can be called up in factory setting directly via DI3 (terminal 10).	10.00
P10.3	106	✓		Fixed frequency FF2 0.00 Hz up to the maximum frequency value (P6.4) This value can be called up in factory setting directly via DI4 (terminal 14).	15.00
P10.4	126	✓		Fixed frequency FF3 0.00 Hz up to the maximum frequency value (P6.4) This value can be called up directly via the common actuation of terminals 10 and 14 (DI3 and DI4) in the factory setting.	20.00
P10.5	127	✓		Fixed frequency FF4 0.00 Hz up to the maximum frequency value (P6.4) For activation, parameter P3.11 must be assigned with a third digital input. For example P3.11 = 5: DI5 (terminal 15). This value can then be called up directly via DI3. **Note:** DI5 (Terminal 15) is occupied in factory setting with the error acknowledgement (Reset). Setting P3.11 = 0 is recommended.	25.00
P10.6	128	✓		Fixed frequency FF5 0.00 Hz up to the maximum frequency value (P6.4) For activation, parameter P3.11 must be assigned with a third digital input. For example P3.11 = 5: DI5 (terminal 15, see notes to P10.5). This value can be called up with a common actuation of terminals 10 (DI3) and 15 (DI5).	30.00
P10.7	129	✓		Fixed frequency FF6 0.00 Hz up to the maximum frequency value (P6.4) For activation, parameter P3.11 must be assigned with a third digital input. For example P3.11 = 5: DI5 (terminal 15, see notes to P10.5). This value can be called up with a common actuation of terminals 14 (DI4) and 15 (DI5).	40.00
P10.8	130	✓		Fixed frequency FF7 0.00 Hz up to the maximum frequency value (P6.4) For activation, parameter P3.11 must be assigned with a third digital input. For example P3.11 = 5: DI5 (terminal 15, see notes to P10.5). This value can be called up with a common actuation of terminals 10 (DI3), 14 (DI4) and 15 (DI5).	50.00

V/Hz-characteristic curve (P11)

The V/Hz-characteristic curve (voltage/frequency characteristic curve) designates a control process for the adjustable frequency drive, with which the motor voltage is controlled in a certain ratio to the frequency. If the voltage/frequency ratio is constant (linear characteristic curve), magnetization of the connected motor is almost constant and therefore the torque as well.

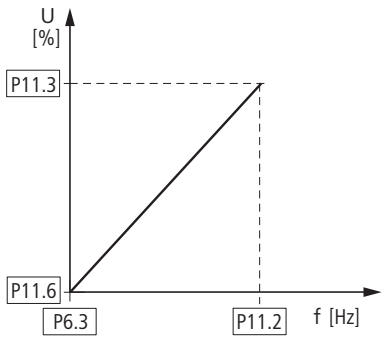
In the standard application, the benchmark values for the V/Hz-characteristic curve correspond with the rated operational data of the connected motor (see ratings plate for the motor):

- Cut-off frequency P11.2 = Rated motor frequency P7.6 = Maximum frequency P6.4
- Output voltage P11.3 = Nominal motor voltage P7.5

→ The rating data of the V/Hz-characteristic curve is assigned automatically and corresponds with the values of parameter P7.5 (nominal motor voltage) and P7.6 (rated motor frequency).

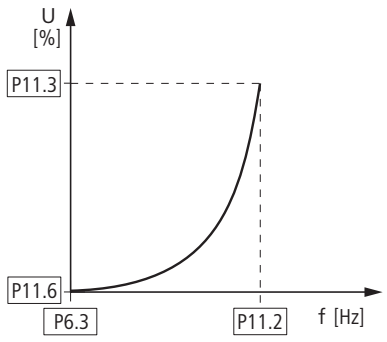
If you require other values for the V/Hz-characteristic curve, you must first set parameters P7.5 and P7.6, before you change the parameters of the V/Hz-characteristic curve shown here.

PNU	ID	Access right RUN	Value	Description	Factory setting
P11.1	108	-		V/f characteristic curve	0
			0	Linear The output voltage changes linearly with the output frequency; from zero to voltage P11.3 with the cut-off frequency P11.2. By defining a minimum frequency (P6.3), a voltage corresponding with one of the linear characteristic curves is output. The V/Hz ratio running linearly between zero and the cut-off frequency remains constant. With parameter P11.6, the voltage value can be raised by percentages in a linear V/Hz-ratio over the entire manipulating range.	
			1	Quadratic The output voltage changes quadratically with the output frequency; from zero to voltage P11.3 with the cut-off frequency P11.2. By defining a minimum frequency P6.3, a voltage corresponding with one of the quadratic characteristic curves is output. The V/Hz ratio running quadratically between zero and the cut-off frequency remains constant. With parameter P11.6, the voltage value can be raised as a percentage be a quadratic V/Hz ratio over the entire manipulating range.	
			2	Parameterizable In connection with parameters P11.4, P11.5 and P11.6, the V/Hz ratio and therefore the parameters for characteristic curve progress can be defined as required.	



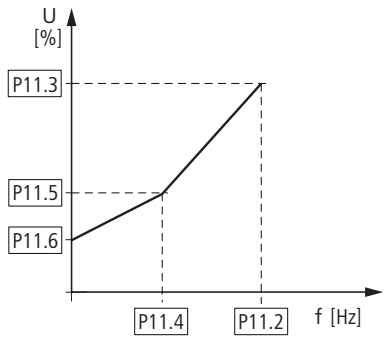
linear

P11.1 = 0



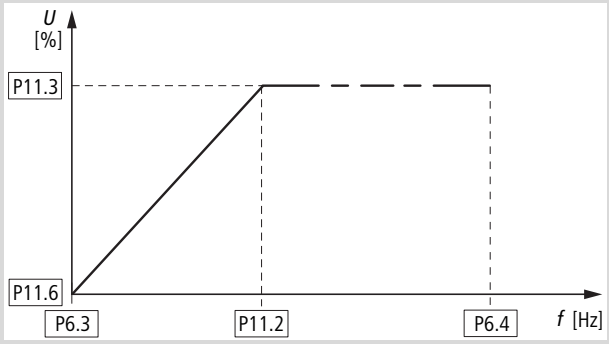
quadratic

P11.1 = 1



parameterizable

P11.1 = 2

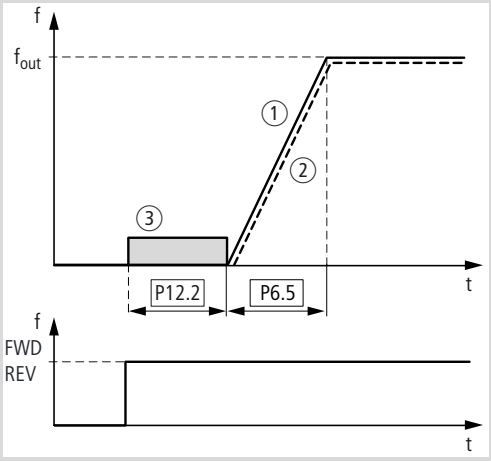
PNU	ID	Access right RUN	Value	Description	Factory setting
P11.2	602	-		Cut-off frequency	50.00
				30.00 – 320.00 Hz The output voltage reaches its maximum rated value P11.3 with the cut-off frequency. For example: 400 V at 50 Hz. If the maximum output frequency (P6.4) is set to higher values, the output voltage remains constant as of the cut-off frequency defined here. As of this cut-off frequency, the voltage/frequency ratio is no longer constant. The magnetization of the connected motor is reduced with increasing frequency (field weakening range).  Example: linear V/Hz characteristic curve with cut-off frequency and field weakening range.	
P11.3	603	-		Output voltage	100.00
				10.00 – 200.00 % of mains voltage In the standard application, the value set here is equal to 100 % of the mains voltage supply and corresponding with the nominal motor voltage set under P7.5 (→ ratings plate motor).	
P11.4	604	-		V/f characteristic curve, mean frequency value	50.00
				0.00 – P11.2 [Hz] Definition of a frequency value for the voltage value set under P11.5 Defined ratio (break-point) for the defined V/Hz-characteristic curve (P11.1 = 2, see characteristic P11.1 = 2)	
P11.5	605	-		V/f characteristic curve, mean voltage value	100.00
				0.00 – P11.3 % Definition of a voltage value for the frequency value set under P11.4 Defined ratio (break-point) for the defined V/Hz-characteristic curve (P11.1 = 2, see characteristic P11.1 = 2)	
P11.6	606	-		Output voltage at 0 Hz	0.00
				0.00 – 40.00 % Definition of a start voltage at 0 Hz (zero frequency voltage). **Note:** A high start voltage enables a high torque at the start. ▽ **Caution:** A high torque at low speed causes a high thermal load on the motor. If temperatures are too high, the motor should be equipped with an external fan.	
P11.7	109	-		Torque increase	0
			0	Not active	
			1	Active An automatic increase in the output voltage (Boost) at high torque load and low speed (e.g. heavy starting duty) ▽ **Caution:** A high torque at low speed leads to a high thermal load on the motor. If temperatures are too high, the motor should be equipped with an external fan.	

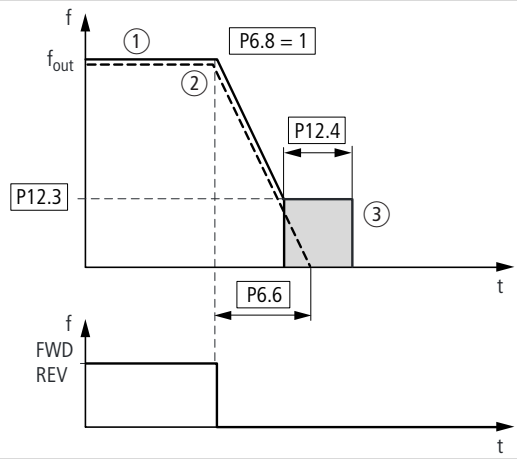
PNU	ID	Access right RUN	Value	Description	Factory setting
P11.8	600	-		Motor control mode	0
			0	Frequency control (V/Hz-characteristic curve) The setpoint input (I/O – KEYPAD – BUS) controls the output frequency of the adjustable frequency drive (resolution of the output frequency = 0.01 Hz). Note: In this mode, multiple motors, with varying outputs, can be connected in parallel in the output of the adjustable frequency drive.	
			1	Speed control (sensorless vector) The setpoint input (I/O – KEYPAD – BUS) controls the motor speed depending on the load torque. Note: In this mode, only one motor with the assigned power (current) may connected in the output of the adjustable frequency drive. **Note:** The speed control requires a precise electrical reproduction of the connected motor. The ratings plate information for the motor must be set in the parameter group P7 in this case.	
P11.9	601	-		Pulse frequency	6.0
				1.5 – 16.0 kHz Using a high switching frequency can reduce the magnetization noise in the motor. **Note:** High switching frequencies reduce the power of the adjustable frequency drive.	

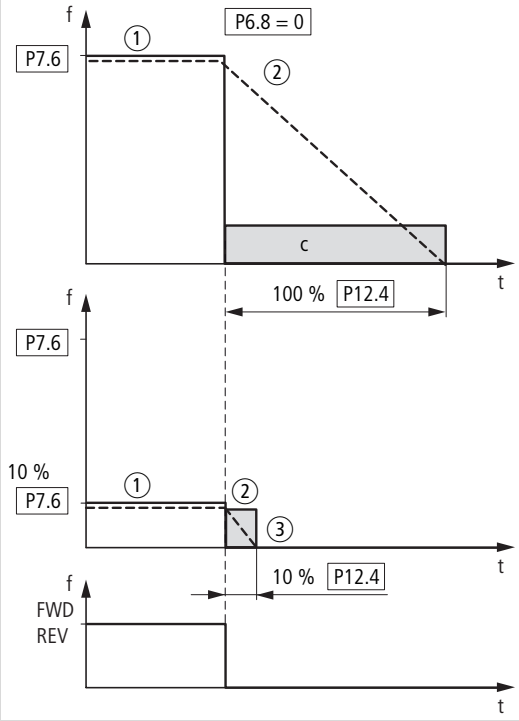
Braking (P12)

Undesirable run-out distances and times can be shortened by the electric braking (DC braking) for the motor. In parameter group P12, you can set the DC braking and the internal brake chopper.

Caution!
DC braking results in additional heating of the motor. Configure the brake torque, set via braking current (P12.1) and the braking duration (P12.2 and P12.4), as low as possible therefore.

PNU	ID	Access right RUN	Value	Description	Factory setting
P12.1	507	-		DC braking, current Set value for the DC current, which supplies the motor during the DC braking. The value depends on the rated operational current I_e of the adjustable frequency drive: 0.2 x I_e – 2 x I_e [A] The parameter is only active, if a value > 0 has been entered for P12.2 or P12.4.	I_e
P12.2	516	-		DC braking, braking time at start 0.00 – 600.00 s The braking time of the DC braking ③ is activated with the start command (FWD, REV).  After the time set here has elapsed, the adjustable frequency drive starts automatically with the acceleration time set under P6.5. The speed of the motor ② follows the curve of the output frequency ①.	0.00

PNU	ID	Access right RUN	Value	Description	Factory setting
P12.3	515	-		DC braking, start frequency during delay ramp 0.00 – 10.00 Hz The output frequency (f_{Out}) set here automatically activates the DC braking after a stop command (FWD/REV switched off). Prerequisite: P6.8 = 1 (Stop function ramp) After the stop command, the output frequency ① is lowered based on the deceleration time set under P6.6. Depending on the inertia and load torque, the speed of the motor ② during the process is reduced accordingly and DC braking occurs with the frequency value set here. You can set the duration of the DC braking ③ under P12.4.  	1.50

PNU	ID	Access right RUN	Value	Description	Factory setting
P12.4	508	-		DC braking, braking time in case of STOP	0.00
				0.00 – 600.00 s Duration of DC braking after the stop command With P6.8 = 1 (Stop function ramp), the activation of the DC braking occurs with the output frequency set under P12.3 with the braking time set here. With P6.8 = 0 (free run-out), the activation of the DC braking ③ occurs directly with the stop command. If the output frequency ① is greater than or equal to the rated motor frequency (P7.6), the value set here is considered for the duration of the braking time. If the output frequency is less than or equal to 10 % of the rated motor frequency (P7.6), the duration for DC braking is reduced respectively to 10 % of the value set here.  	
P12.5	504	-		Brake chopper	0
				This function is only activated with the three-phase adjustable frequency drives MMX34…3D4… (3.4 A) to MMX34…014… (14 A). The capacities have an internal braking transistor, which with greater centrifugal forces or short deceleration times, can dissipate the excess braking energy through an external high-capacity resistor (connection terminals R+ and R-). **Note:** With adjustable frequency drives without braking transistors, this parameter is not visible.	
			0	Brake-chopper deactivated	
			1	Automatic activation in operation (RUN)	
			2	Automatic activation in operation (RUN) and upon stop (STOP)	

System parameter

The system parameters (S parameters) inform the user of device-specific settings.

→ The S parameters are not visible (i. e. hidden), as long as you have activated the quick-start assistant (P1.1 =1, see section "Parameter menu (PAR)", page 69).

PNU	ID	Access right RUN	Value	Description	Factory setting
Hard- and Software Information					
S1.1	833	-	x	Software package	-
S1.2	834	-	xx	Power section, Software version	-
S1.3	835	-	x.xx	Control part software version	-
S1.4	836	-	x.xx	Firmware interface	-
S1.5	837	-	xxxx	Application ID	-
S1.6	838	-	x.xx	Application revision	-
S1.7	839	-	xx	System load	-
				Load as percentage [%]	
Communication **Information on interface RS485 (control signal terminals A, B)**					
S2.1	808	-	xx.yyy	Communication status	0.00
				xx = Number of error messages (0 to 64) yyy = Number of correct messages (0 to 999)	
S2.2	809	-		Field bus protocol	0
			0	Field bus deactivated	
			1	Modbus RTU	
S2.3	810	-		Slave address	1
				Station address 1 to 255	
S2.4	811	-		Baud rate	5
				Transfer rate (1 Baud = 1 symbol per second) The baud rate must be equal on the send and receive sides.	
			0	= 300 Baud	
			1	= 600 Baud	
			2	= 1200 Baud	
			3	= 2400 Baud	
			4	= 4800 Baud	
			5	= 9600 Baud	
S2.5	812	-		Number of stop bits	1
			0	= 1 Stop bit	
			1	= 2 Stop bits	
S2.6	813	-		Parity type	0
			0	= No function (inaccessible)	
S2.7	814	-		Communication timeout	0
			0	= Not used	
			1	= 1 s	
			2	= 2 s	
			…255	= up to 255 s	

PNU	ID	Access right RUN	Value	Description	Factory setting
S2.8	815	-		Reset communication status	0
			0	= Not used	
			1	= Resets parameter S2.1	
Unit counter					
S3.1	827	-	-	MWh counter	0.00
S3.2	828	-	-	Operating days [d]	0
S3.3	829	-		Operating hours [h]	0
User Set					
S4.1	830	-	0 – 15	Display contrast	15
S4.2	831	-		Factory setting (WE)	0
			0	= Factory setting or changed value (user setting for parameter)	
			1	= Restores factory settings for all parameters	

Operational data indicator (MON)

By applying the specified supply voltage (L1, L2/N, L3), the LCD display is illuminated (= Power ON) and all segments are shown briefly. The parameter number (M1.1) and the respective display value (0.00) are then displayed automatically in alternating sequence.

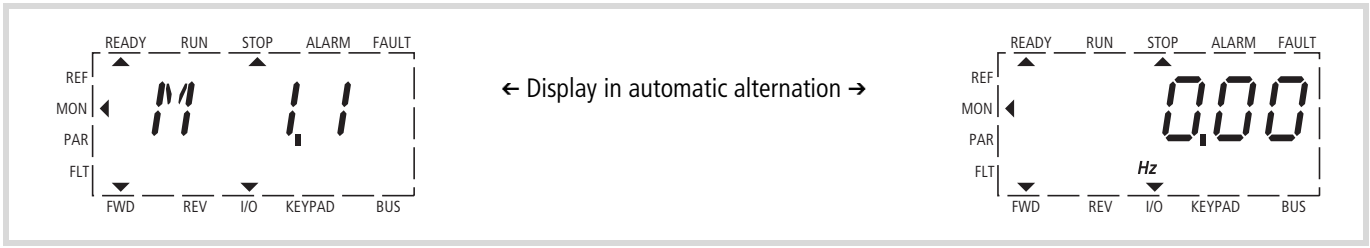


Figure 80: Operational data indicator

You can use the MON (Monitor) menu level to select the desired operational data indicator (parameter number M…) with the arrow buttons ∧ and ∨. The parameter number and the display value are shown in alternation automatically, and the display can be fixed on the selected display value with the OK button. If you wish to access a different operational data indicator, press the OK button once again. You can then make the selection with the arrow buttons ∧ und ∨ and confirm with the OK button. The appropriate unit is shown under the respective operational data indicator.

→ The selected operational data indicator setting is erased when the supply voltage is switched off. If the supply voltage is switched back on, the parameter number (M1.1) and the display value (0.00) are shown in automatic alternation again.

→ The values of the operating data display cannot be changed by hand (i. e. by value entry).

→ You can select operational data indicators during operation (RUN).

PNU	ID	Designation	Display value	Unit	Description
M1.1	1	Output frequency	0.00	Hz	Frequency to motor
M1.2	25	Frequency reference value	0.00	Hz	Frequency reference value
M1.3	2	Motor shaft speed	0	rpm	Calculated speed of the motor (rpm)[1)]
M1.4	3	Motor current	0.00	A	Measured motor current
M1.5	4	Motor torque	0.0	%	Calculated ratio of torque to rated torque of the motor[1)]
M1.6	5	Motor power	0.0	%	Calculated ratio of actual output power to rated motor output[1)]
M1.7	6	Motor voltage	0.0	V	Measured output voltage to motor
M1.8	7	Intermediate circuit DC voltage	000	V	Measured intermediate circuit voltage (depending on the supply voltage)
M1.9	8	Unit temperature	00	°C	Measured heat sink temperature
M1.11	13	Analog input 1	0.0	%	Value on AI1
M1.12	14	Analog input 2	0.0	%	Value on AI2
M1.13	26	Analog output 1	0.0	%	Value on AO1
M1.14	15	Digital input	0	-	DI1, DI2, DI3 status
M1.15	16	Digital input	0	-	DI4, DI5, DI6 status
M1.16	17	Digital output	1	-	RO1, RO2, DO status

PNU	ID	Designation	Display value	Unit	Description
M1.17	20	PI setpoint	0.0	%	Percentage of maximum setpoint
M1.18	21	PI feedback	0.0	%	Percentage of maximum actual value
M1.19	22	PI error value	0.0	%	Percentage of maximum fault value
M1.20	23	PI Output	0.0	%	Percentage of maximum output value

1) The calculated motor data (M1.3, M1.5 and M1.6) is based on the values entered in parameter group P7 (→ section "Motor (P7)", page 84).
2) The calculated motor temperature (M1.10) considers the temperature model of the protection function in parameter group P8 (→ section "Protective functions (P8)", page 86)

→ Under the system parameters S3.1 to S4.1 (see section "System parameter", page 99) you can also display the operational data of the M-Max adjustable frequency drive and adjust the contrast of the display unit.

Example of status displays

The status displays of the digital inputs and outputs are equivalent. These make it possible to check for whether an output control signal (e.g. from an external controller) activates the adjustable frequency drive. This provides you with a simple means for checking the wiring (wire breakage).

The following table shows a few examples.

Display value:

- 1 = activated = High
- 0 = not activated = Low

PNU	ID	Display value	Description
M1.14	15	0	No digital input (DI1, DI2, DI3) is actuated.
		1	DI3 (Terminal 8) is actuated.
		10	DI2 (Terminal 9) is actuated.
		100	DI1 (Terminal 10) is actuated.
		101	Terminals DI3 and DI1 are actuated.
		111	Terminals DI3 and DI2 and DI1 are actuated.
M1.15	16	1	DI14 (Terminal 14) is actuated.
		10	DI15 (Terminal 15) is actuated.
		100	DI16 (Terminal 16) is actuated.
M1.16	17	1	DO (Terminal 20). The transistor is active and has linked terminal 20 with GND.
		10	Relay RO2 is actuated. Terminals 25 (R22) and 26 (R24) are linked (closed changeover contact).
		100	Relay RO1 is actuated. N/O terminal 22 (R13) and 23 (R14) is closed.

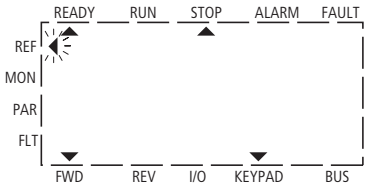
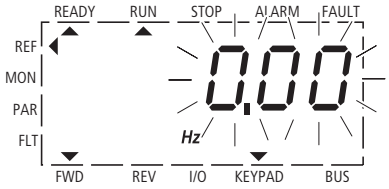
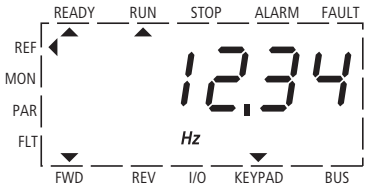
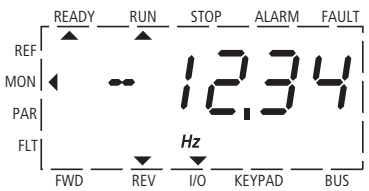
Setpoint input (REF)

REF: Setpoint value definition (Reference) via the operating unit

The settings of the frequency setpoint valve via the operating unit are comparably effective with the function of an electronic motor potentiometer. The set value is also retained after shutting off the supply voltage.

→ A frequency setpoint value that is set under REF is only effective with the KEYPAD control level activated.

The following table shows a good example of specifying the frequency setpoint value via the operating unit.

Sequence	Commands	Display	Description
1	LOC REM		Activate control level KEYPAD with the LOC/REM button.
	BACK RESET		Actuating the BACK/RESET button activates the menu level (arrow flashes).
	∧		With arrow button ∧ or ∨ you can then select menu point REF.
	OK		The OK button activates the setpoint input REF.
2	OK		In menu point REF, the stored frequency setpoint is shown (factory setting 0.00 Hz). To change the frequency setpoint, you must activate the entry with the OK button. The activated input is indicated with the flashing numbers (Hz). **Note:** Changes in the frequency setpoint are only possible if the number display is flashing (Hz), even in RUN mode. The value is stored when the display is constant. **Note:** In STOP mode, the direction of the field of rotation FWD is always indicated (Base value). The selected field of rotation direction is only marked with the release signal. With REV, a minus sign precedes the displayed frequency setpoint value.
3a	∧		You can set the frequency setpoint value (when the number display is flashing) with the arrow button ∧ : • increase with field of rotation direction FWD, up to maximum frequency (P6.4), • reduce with field of rotation REV, from set frequency setpoint to 0 Hz, • reduce with field of rotation direction REV, from set frequency setpoint value to 0 Hz and, if P6.14 = 0, automatic reversal of the field of rotation direction to FWD and increase to maximum frequency (P6.4).
3b	∨		You can set the frequency setpoint with the arrow button ∨ (with the number display flashing): • increase the field of rotation direction REV, up to maximum frequency (P6.4), • reduce with field of rotation direction FWD, from set frequency setpoint to 0 Hz, • reduce with field of rotation direction FWD, from set frequency setpoint to 0 Hz and, if P6.14 = 0, automatic reversal to field of rotation direction REV and increase to maximum frequency (P6.4).

7 Serial interface (Modbus RTU)

Introduction

The following figure shows the position of the terminal connections for the serial interface A-B.

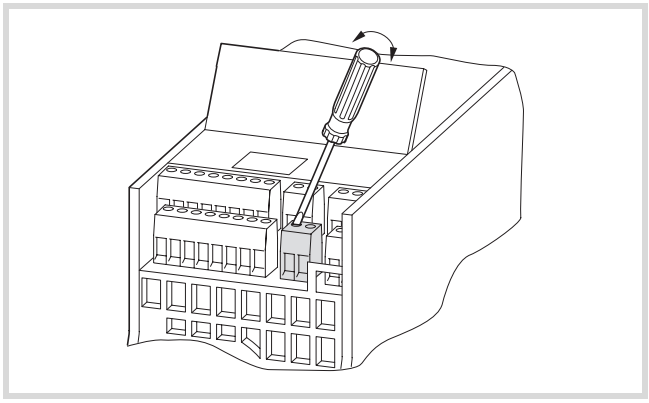


Figure 81: Serial interface A-B (RS 485, Modbus RTU)

Only one message can exist on the data line at any given time. A slave cannot initiate a transfer, it only reacts with a response to a request from the master. Cross-traffic between the individual slaves is not possible.

→ More information on Modbus can be found in the Internet under www.modbus.org.

The electrical connection between the master and the parallel slaves is made via a serial interface with two-wire cable RS485.

Modbus is an open communication protocol based on so-called master-slave communication. The master (PLC, PC, Host-Computer) initiates and controls all data traffic.

Between the master and the slave (subordinate participant), only two types of dialog are possible:

- The master sends a message to a single slave and waits for a response.
- The master sends a message to all slaves and does not wait for a response (broadcast).

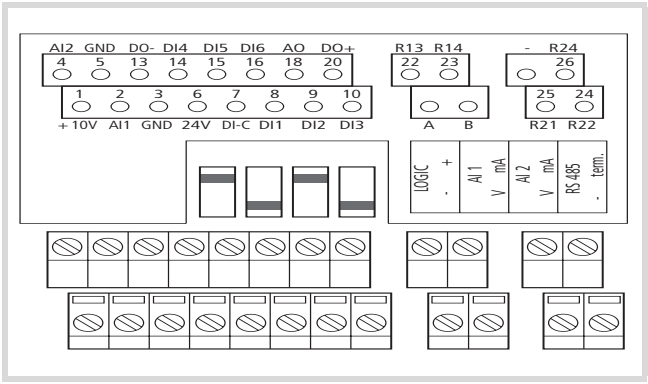


Figure 82: Microswitch S1-2 in position ON (A-B: 120 Ω)

For operation on a Modbus network, every adjustable frequency drive must have a unique address. The settings for the M-Max adjustable frequency drive for operation on a Modbus network can be made in the system parameters (Group S2…).

PNU	ID	Access right RUN	Designation	Value range	Factory setting	User setting
S2.1	808	-	Communication status	Format xx.yyy xx = number of error messages (0 - 64) yyy = number of correct messages (0 - 999)		
S2.2	809	-	Error bus protocol	0 = field bus deactivated 1 = Modbus	0	
S2.3	810	-	Slave address	1 – 255	1	
S2.4	811	-	Baud rate	0 = 300 1 = 600 2 = 1200 3 = 2400 4 = 4800 5 = 9600	5	
S2.5	812	-	Number of stop bits	0 = 1 stop bit 1 = 2 stop bit	1	

PNU	ID	Access right RUN	Designation	Value range	Factory setting	User setting
S2.6	813	-	Parity type	0 = No function (blocked)	0	
S2.7	814	-	Communication timeout	0 = Not used 1 = 1 s 2 = 2 s … 255 s	0	
S2.8	815	-	Reset communication status	0 = Not used 1 = resets parameter S2.1	0	

Operating mode Modbus RTU

Operating mode Modbus RTU (Remote Terminal Unit) transfers the data in binary format (faster data rate) and determines the transfer format for the data request and the data response. Each message byte that is sent contains two hexadecimal characters (0 … 9, A … F).

The data message is limited in its maximum length and is made up of the following elements:

Slave address	Functions-Code	Data	CRC
1 Byte	1 Byte	N x 1 Byte	2 bytes

The device address specifies the device and can be assigned with M-Max under parameter S2.3 (slave address) within a range from 1 to 255. D device address 0 is used as a broadcast message by the master. The function code defines the type of message. The following actions can be performed with M-Max:

Function code [hex]	Designation	Description
03	Read Holding Registers	Reads the output register in the slave (process data, parameters, configuration)
04	Read Input Register	Reads the input register in the slave (process data, parameters, configuration)
06	Preset Single Register	Default setting for a single register. This setting is performed in all slaves for a general telegram (Broadcast). The register is read back for comparison.

The length of the data block (Data: N x 1 Byte) is independent of the function code. It is made up of two hexadecimal character strings, each in a range from 00 to FF. The data block contains additional information for the slave so that the actions that are defined in the function code by the master can be executed. For example: Designating the individual addresses and register addresses, the number of parameters to be process, actual value data bytes.

The telegrams in the Modbus RTU have a CRC (Cyclical Redundancy Check). This CRC field consists of two bytes that contain a binary 16 bit value. The CRC check is always run independently of the parity check for the individual characters of the telegram. The CRC result is attached to the end of the telegram by the master. The slave recalculates while receiving the telegram and compares the calculated value with the actual value in the CRC field. If the values are not identical, an error is set.

Caution!
The master cyclically polls slaves' fault messages. It is therefore advisable to send device-specific and safety-relevant fault messages directly through the control signal terminals (for example fault indication relays).

Example: A short-circuit in the motor conductor at the output of the adjustable frequency drive switches on the mechanical brake directly.

PNU	ID	Access right RUN	Value	Description	Factory setting
P6.1	125	✓		Select control level	1
			1	Control signal terminals (I/O) You can switch directly between I/O and KEYPAD with the LOC/REM button.	
			2	Control unit (KEYPAD) The LOC/REM button has no function here.	
			3	Interface (BUS) You can switch directly between BUS and KEYPAD with the LOC/REM button.	

The following tables show the contents of the processor data in the factory setting.

Output process data

ID	Modbus Register	Designation	Manipulated variable	Part no.
2101	32101, 42101	Status word (BUS) ① (see page 109)	-	Binary code
2102	32102, 42102	General status word (BUS)	-	Binary code
2103	32103, 42103	Actual speed (BUS) ② (see page 109)	0.01	%
2104	32104, 42104	Motor frequency	0.01	+/- Hz
2105	32105, 42105	Motor speed	1	+/- 1/min
2106	32106, 42106	Motor current	0.01	A
2107	32107, 42107	Motor speed	0.1	+/- % (of the nominal value)
2108	32108, 42108	Motor power	0.1	+/- % (of the nominal value)
2109	32109, 42109	Motor voltage	0.1	V
2110	32110, 42110	DC-link voltage (DC)	1	V
2111	32111, 42111	Active fault	-	Failure code

Input process data

ID	Modbus Register	Designation	Manipulated variable	Part no.
2001	32001, 42001	Control word (BUS) ③ (see page 109)	-	Binary code
2002	32002, 42002	General control word (BUS)	-	Binary code
2003	32003, 42003	Speed reference value (BUS) ④ (see page 109)	0.01	%
2004	32004, 42004	PI controller, setpoint value	0.01	%
2005	32005, 42005	PI actual value	0.01	%
2006	32006, 42006	-	-	-
2007	32007, 42007	-	-	-
2008	32008, 42008	-	-	-
2009	32009, 42009	-	-	-
2010	32010, 42010	-	-	-
2011	32011, 42011	-	-	-

Bit Definition

Bit	Description: Value = 0	Description: Value = 1
RUN	Stop	Operation, run message
DIR	Clockwise rotating field (FWD)	Anticlockwise rotating field (REV)
RST	The rising edge of this bit resets the active fault (Reset).	The rising edge of this bit resets the active fault (Reset).
RDY	Drive not ready	Ready
FLT	No fault	Fault detected (FAULT)
W	No warning	Warning active (ALARM)
AREF	Acceleration ramp	Frequency actual value equals setpoint value definition
Z	-	Zero speed

Output process data
Status word ①
Information on the device status and messages are defined in the status word. The status word is made up of 16 bits.

15	14	13	12	11	10	9	08	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	Z	AREF	W	FLT	DIR	RUN	RDY

Actual speed (frequency actual value) ②
The actual speed of the adjustable frequency drive is within a value range of -10,000 and 10,000. In the application, this value is scaled to a percentage in the frequency range between the defined minimum and maximum frequencies.

15	14	13	12	11	10	09	8	7	6	5	4	3	2	1	0
MSB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LSB

Input process data
Control word ③
The first three bits serve in controlling the adjustable frequency drive. You can adapt the content for your own application and then set it as a control word to the M-Max adjustable frequency drive.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	-	-	-	-	-	-	RST	DIR	RUN

Speed reference value (frequency setpoint value) ④
Setpoint value 1 is normally used as a speed reference value for the adjustable frequency drive. The permissible value range is between 0 and 10,000.

In the application, this value is scaled to a percentage in the frequency range between the defined minimum and maximum frequencies.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	LSB

Appendix

Special technical data

The following tables show the technical data of the adjustable frequency drive M-Max in the individual power classes with the allocated motor output.

→ The motor output allocation is based on the rated operational current.

→ The motor output designates the respective active power output to the drive shaft of a normal, four pole, internally or externally ventilated three-phase asynchronous motor with 1500 rpm (at 50 Hz) or 1800 rpm (at 60 Hz).

Device series MMX11

MMX11		Unit	1D7	2D4	2D8	3D7	4D8
Rated current (I_e)		A	1.7	2.4	2.8	3.7	4.8
Overload current for 60 s every 600 s at 50 °C		A	2.6	3.6	4.2	5.6	7.2
Starting current for 2 s every 20 s at 50 °C		A	3.4	4.8	5.6	7.4	9.6
Apparent power at rated operation	230 V	kVA	0.68	0.96	1.12	1.47	1.91
	240 V	kVA	0.71	0.99	1.16	1.54	1.99
Assigned motor rating (230 V)		kW	0.19	0.37	0.55	0.75	1.10
		HP	1/4	1/2	3/4	1	1 1/5
Power side (primary side):							
Number of phases			Single phase (L and N)				
Rated voltage (U_{LN})		V	110 V -15 % – 120 V +10 %, 50/60 Hz				
Input current (I_{LN})		A	4.2	11.6	12.4	15	16.5
Leakage current to ground (PE)							
Proper connection		mA					
Phase interrupted		mA					
Neutral conductor interrupted		mA					
Braking torque							
Default			max. 30 % M_N				
DC braking			Maximum 100 % rated operational current I_e, adjustable				
Pulse frequency		kHz	6 (adjustable 1 – 16)				
Heat dissipation at rated current (I_e)		W	22	27	33	40	49
Efficiency		η	0.91	0.92	0.94	0.95	0.96
Fan (device-internal, temperature-controlled)			✓	✓	✓	✓	✓
Installation size			FS1	FS2	FS2	FS2	FS2
Weight		kg	0.7	0.7	0.7	0.7	0.99

Device series MMX12

MMX12		Unit	1D7	2D4	2D8	3D7	4D8	7D0	9D6
Rated current (I_e)		A	1.7	2.4	2.8	3.7	4.8	7	9.6
Overload current for 60 s every 600 s at 50 °C		A	2.6	3.6	4.2	5.6	7.2	10.4	14.4
Starting current for 2 s every 20 s at 50 °C		A	3.4	4.8	5.6	7.4	9.6	14	19.2
Apparent power at rated operation	230 V	kVA	0.68	0.96	1.12	1.47	1.91	2.79	3.82
	240 V	kVA	0.71	0.99	1.16	1.54	1.99	2.91	3.99
Assigned motor rating (230 V)		kW	0.25	0.37	0.55	0.75	1.1	1.5	2.2
		HP	1/3[1)]	1/2	1/2	3/4	1	2	3
Power side (primary side):									
Number of phases			Single phase (L and N) or double phase (e.g. L1 and L2)						
Rated voltage (U_{LN})		V	208 V -15 % – 240 V +10 %, 50/60 Hz (177 – 264 V ±0 %, 45 – 66 Hz ±0 %)						
Input current (I_{LN})		A	4.2	5.7	6.6	8.3	11.2	14.1	15.8
Leakage current to ground (PE)									
Proper connection		mA				2.7		3.4	
Phase interrupted		mA				46		40.2	
Neutral conductor interrupted		mA				59.75		77.4	
Braking torque									
Default			max. 30 % M_N						
DC braking			Maximum 100 % rated operational current I_e, adjustable						
Pulse frequency		kHz	6 (adjustable 1 – 16)						
Heat dissipation at rated current (I_e)		W	17.9	24.6	29.2	40.2	49.6	66.8	78.1
Efficiency		η	0.93	0.93	0.95	0.95	0.95	0.96	0.96
Fan (device-internal, temperature-controlled)			✓	✓	✓	✓	✓	✓	✓
Installation size			FS1	FS1	FS1	FS1	FS2	FS2	FS3
Weight		kg	0.55	0.55	0.55	0.55	0.7	0.7	0.99

1) Recommended value, no standardized performance variable

Device series MMX32

MMX32		Unit	1D7	2D4	2D8	3D7	4D8	7D0	9D6
Rated current (I_e)		A	1.7	2.4	2.8	3.7	4.8	7	9.6
Overload current for 60 s every 600 s at 50 °C		A	2.6	3.6	4.2	5.6	7.2	10.4	14.4
Starting current for 2 s every 20 s at 50 °C		A	3.4	4.8	5.6	7.4	9.6	14	19.2
Apparent power at rated operation	230 V	kVA	0.68	0.96	1.12	1.47	1.91	2.79	3.82
	240 V	kVA	0.71	0.99	1.16	1.54	1.99	2.91	3.99
Assigned motor rating (230 V)		kW	0.25	0.37	0.55	0.75	1.1	1.5	2.2
		HP	1/3[1)]	1/2	1/2	3/4	1	2	3
Power side (primary side):									
Number of phases			Three-phase (L1, L2, L3)						
Rated voltage (U_{LN})		V	208 V -15 % – 240 V +10 %, 50/60 Hz (177 – 264 V ±0 %, 45 – 66 Hz ±0 %)						
Input current (I_{LN})		A	2.7	3.5	3.8	4.3	6.8	8.4	13.4
Leakage current to ground (PE)									
Proper connection		mA							
One phase interrupted		mA							
Two phases interrupted		mA							
Braking torque									
Default			max. 30 % M_N						
DC braking			Maximum 100 % rated operational current I_e, adjustable						
Pulse frequency		kHz	6 (adjustable 1 – 16)						
Heat dissipation at rated current (I_e)		W	17.4	23.7	28.3	37.9	48.4	63.8	84
Efficiency		h	0.93	0.94	0.95	0.95	0.96	0.96	0.96
Fan (device-internal, temperature-controlled)			✓	✓	✓	✓	✓	✓	✓
Installation size			FS1	FS1	FS1	FS1	FS2	FS2	FS3
Weight		kg	0.55	0.55	0.55	0.55	0.7	0.7	0.99

1) Recommended value, no standardized performance variable

Device series MMX34

MMX34		Unit	1D3	1D9	2D4	3D3	4D3	5D6	7D6	9D0	012	014[1]
Rated current (I_e)		A	1.3	1.9	2.4	3.3	4.3	5.6	7.6	9	12	14
Overload current for 60 s every 600 s at 50 °C		A	2	2.9	3.6	5	6.5	8.4	11.4	13.5	18	21
Starting current for 2 s every 20 s at 50 °C		A	2.6	3.8	4.8	6.6	8.6	11.2	15.2	18	24	28
Apparent power in rated operation	400 V	kVA	0.9	1.32	1.66	2.29	2.98	3.88	5.27	6.24	8.32	9.7
	480 V	kVA	1.08	1.56	2	2.74	3.57	4.66	6.32	7.48	9.98	11.64
Assigned motor rating	400 V	kW	0.37	0.55	0.75	1.1	1.5	2.2	3	4	5.5	7.5 [2]
	460 V	HP	1/2	3/4	1	1-1/2	2	3	4[3]	5	7-1/2	10
Power side (Primary side)												
Number of phases			Three-phase (L1, L2, L3)									
Ratedvoltage (U_{LN})		V	380 V - 15 % – 480 V + 10 %, 50/60 Hz (323 – 528 V ±0 %, 45 – 66 Hz ±0 %)									
Input current (I_{LN})		A	2.2	2.8	3.2	4	5.6	7.3	9.6	11.5	14.9	18.7
Leakage current to ground (PE)												
Proper connection		mA				4.8						
One phase interrupted		mA				109.5						
Two phases interrupted		mA				110.2						
Braking torque			max. 30 % M_N									
Default												
Brake-Chopper with external braking resistance			-	-	-	-	Max. 100 % rated current I_e with external braking resistance.					
Minimum braking resistance		Ω	-	-	-	-	55	55	35	35	35	35
Switch-on threshold for the braking transistor		V DC	-	-	-	-	765	765	765	765	765	765
DC braking			Maximum 100 % rated operational current I_e, adjustable									
Pulse frequency		kHz	6 (adjustable 1 – 16)									1 – 4
Heat dissipation at rated current (I_e)		W	21.7	29.7	31.7	51.5	66.4	88.3	116.9	136.2	185.1	223.7
Efficiency		h	0.94	0.95	0.95	0.95	0.96	0.96	0.96	0.97	0.97	0.97
Fan (device-internal, temperature-controlled)			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Installation size			FS1	FS1	FS1	FS1	FS2	FS2	FS3	FS3	FS3	FS3
Weight		kg	0.55	0.55	0.55	0.55	0.7	0.7	0.99	0.99	0.99	0.99

1) The rated operational data of the MMX34AA014… is limited to 4 kHz at a maximum ambient temperature of +40 °C.

2) Allocated motor output with reduced load torque (about -10 %)

3) Recommended value, no standardized size

Dimensions and frame size

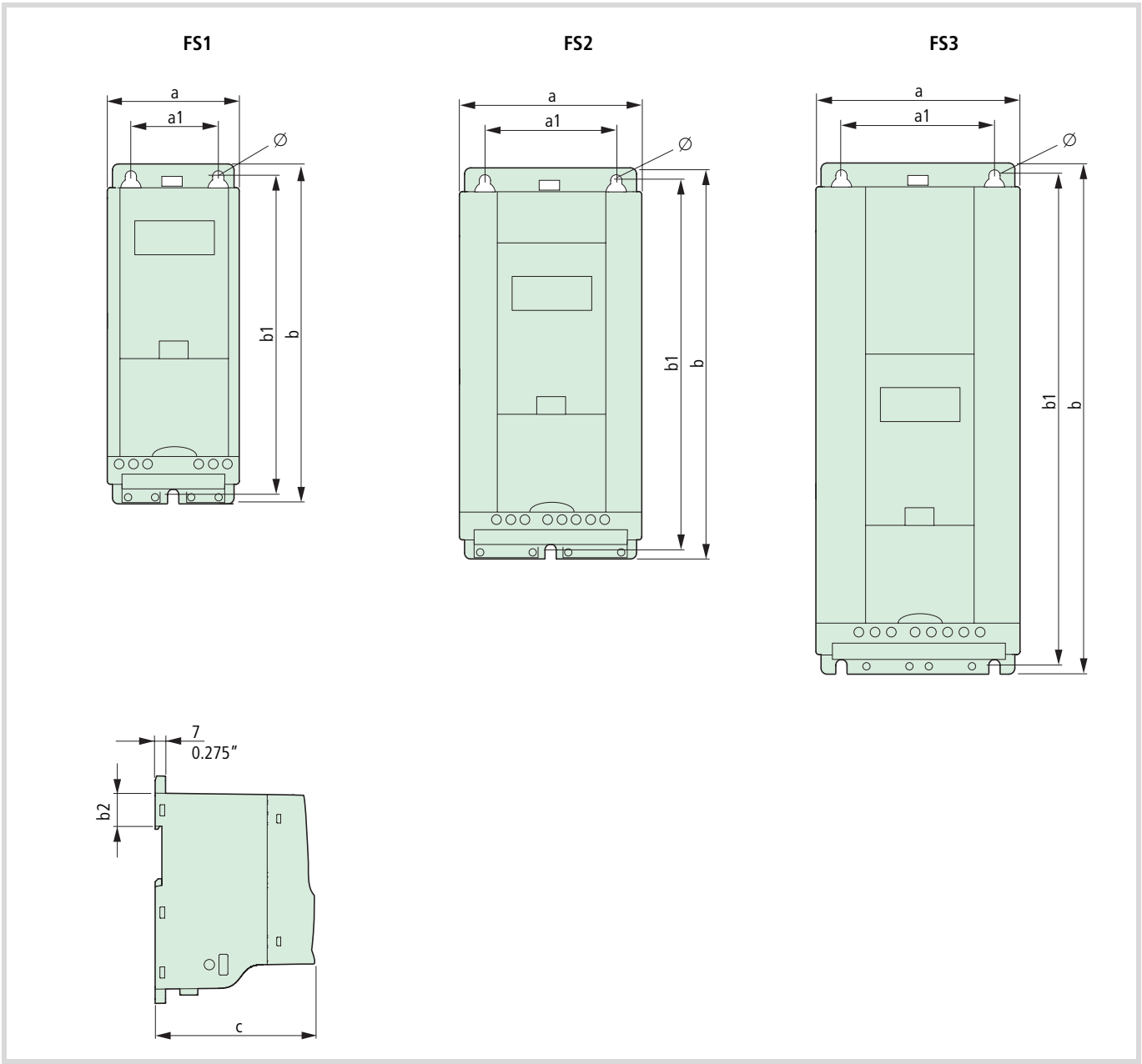


Figure 83: Dimensions and frame sizes (FS = Frame Size)

Table 9: Dimensions and frame sizes

Model	a [mm]	a1 [mm]	b [mm]	b1 [mm]	b2 [mm]	c [mm]	Ø	Installation size
MMX12AA1D7F0-0 MMX12AA2D4F0-0 MMX12AA2D8F0-0 MMX12AA3D7F0-0 MMX32AA1D7F0-0 MMX32AA2D4F0-0 MMX32AA2D8F0-0 MMX32AA3D7F0-0 MMX34AA1D3F0-0 MMX34AA1D9F0-0 MMX34AA2D4F0-0 MMX34AA3D3F0-0	66 (2.6'')	38 (1.5'')	157 (6.18'')	147 (5.79'')	32 (3.9'')	102 (4.02'')	4.5 (0.18'')	FS1
MMX11AA1D7N0-0 MMX11AA2D4N0-0 MMX11AA2D8N0-0 MMX11AA3D7N0-0 MMX12AA4D8F0-0 MMX12AA7D0F0-0 MMX32AA4D8F0-0 MMX32AA7D0F0-0 MMX34AA4D3F0-0 MMX34AA5D6F0-0	90 (3.54'')	62.5 (2.46'')	195 (7.68'')	182 (7.17'')	32 (1.26'')	105 (4.14'')	5.5 (2.17'')	FS2
MMX11AA4D8N0-0 MMX12AA9D6F0-0 MMX32AA9D6F0-0 MMX34AA7D6F0-0 MMX34AA9D0F0-0 MMX34AA012F0-0 MMX34AA014F0-0	100 (3.94'')	75 (2.95'')	253 (9.96'')	242 (9.53'')	34 (1.34'')	112 (4.41'')	5.5 (2.17'')	FS3

1 inch (1'') = 25.4 mm, 1 mm = 0.0394 inch

Cables and fuses

The cross-sections of the cables and line protection fuses used must correspond with local standards.

For an installation in accordance with UL guidelines, the fuses and copper cable that are UL-approved and have a heat-resistance of +60/75 °C are to be used.

Use power cables with insulation according to the specified mains voltages for the permanent installation. A shielded cable is not required on the mains side. On the motor side however, a complete (360°), low-impedance, shielded cable is necessary.

The length of the motor cable depends on the radio interference class and is a maximum of 30 m at M-Max.

Table 10: Fuses and Maximum Cross-Sections

	F1, Q1 =		L1, L2/N, L3		U, V , W		R+, R-		PE	
	1~	3~	mm²	AWG[1)]	mm²	AWG[1)]	mm²	AWG[1)]	mm²	AWG[1)]
MMX12AA1D7F0-0 MMX12AA2D4F0-0 MMX12AA2D8F0-0 MMX12AA3D7F0-0	10 A	-	2 x 1.5	2 x 16	3 x 1.5	3 x 16	-	-	1.5	16
MMX32AA1D7F0-0 MMX32AA2D4F0-0 MMX32AA2D8F0-0 MMX32AA3D7F0-0 MMX34AA1D3F0-0 MMX34AA1D9F0-0 MMX34AA2D4F0-0 MMX34AA3D3F0-0	-	6 A	3 x 1.5	3 x 16	3 x 1.5	3 x 16	-	-	1.5	16
MMX11AA1D7N0-0 MMX11AA2D4N0-0 MMX11AA2D8N0-0 MMX11AA3D7N0-0 MMX12AA4D8F0-0 MMX12AA7D0F0-0	20 A	-	2 x 2.5	2 x 14	3 x 2.5	3 x 14	-	-	2.5	14
MMX32AA4D8F0-0 MMX32AA7D0F0-0	-	10 A	3 x 1.5	3 x 16	3 x 1.5	3 x 16	-	-	1.5	16
MMX34AA4D3F0-0 MMX34AA5D6F0-0			3 x 1.5	3 x 16	3 x 1.5	3 x 16	2 x 1.5	2 x 16	1.5	16
MMX11AA4D8N0-0	30 A	-	2 x 6	2 x 10	3 x 6	3 x 10	-	-	6	10
MMX12AA9D6F0-0	32 A[1)]	-	2 x 6	2 x 10	3 x 6	3 x 10	-	-	6	10
MMX32AA9D6F0-0 MMX34AA7D6F0-0 MMX34AA9D0F0-0 MMX34AA012F0-0	-	20 A	3 x 2.5	3 x 14	3 x 2.5	3 x 14	2 x 2.5	2 x 14	2.5	14
MMX34AA014F0-0	-	25 A	3 x 4	3 x 12	3 x 4	3 x 12	3 x 4	2 x 12	4	12

1) 30 A with AWG
AWG = American Wire Gauge

List of parameters

Quick configuration (basis)

→ When first switching on or after activating the default settings (S4.2 = 1), you are guided step by step through the provided parameters by the quick-start assistant. The defined values are confirmed with the OK button or they can be changed to suit your application and the motor data.

The quick-start assistant can be switched off in the first parameter (P1.1) by entering a zero (access to all parameters).

In parameter P1.2, you can switch to the specified application setting with the quick-start assistant (see table 8, page 72).

The quick-start assistant ends this first cycle by automatically switching to frequency display (M1.1 = 0.00 Hz).

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
P1.1	115	✓	Parameter ranges	0 = All parameters 1 = Only quick configuration parameters	1	71	
P1.2	540	-	Applications	0 = Basic 1 = Pump drive 2 = Fan drive 3 = Hoisting device (high load)	0	71	
P6.1	125	✓	Control level	1 = Control signal terminals (I/O) 2 = Control unit 3 = Interface (BUS)	1	80	
P6.2	117	✓	Setpoint input	0 = Fixed speed (FF0 to FF7) 1 = Control unit (UP/DOWN) 2 = Interface (BUS) 3 = AI1 (analog setpoint 1) 4 = AI2 (analog setpoint 2)	3	80	
P6.3	101	-	Minimum frequency	0.00 – P6.4 Hz	0.00	81	
P6.4	102	-	Maximum frequency	P6.3 – 320 Hz	50.00	81	
P6.5	103	-	Acceleration time	0.1 – 3000 s	3.0	81	
P6.6	104	-	Deceleration time	0.1 – 3000 s	3.0	81	
P6.8	506	-	Stop function	0 = Fee coasting 1 = Ramp (deceleration)	0	82	
P7.1	113	-	Motor nominal current	$0.2 \times I_e – 2 \times I_e$ (→ Motor rating plate)	I_e	85	
P7.3	112	-	Motor nominal speed	300 – 20000 rpm (→ Motor rating plate)	1440	85	
P7.4	120	-	Motor power factor (cos φ)	0.30 – 1.00 (→ Motor rating plate)	0.85	85	
P7.5	110	-	Motor nominal voltage	180 – 500 V (→ Motor rating plate)	230 400	85	
P7.6	111	-	Nominal motor frequency	30 - 320 Hz (→ Motor rating plate)	50.00	85	
P11.7	109	-	Torque increase	0 = Not enabled 1 = Enabled	0	94	
M1.1	1	-	Output frequency	Hz	0.00	101	-

By selecting the parameter level (PAR) again, besides the selected parameters for the quick-configuration, the system parameters (S) are also shown in other cycles.

System parameters in the quick-configuration

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
S1.1	833	-	Software package	-	-	99	
S1.2	834	-	Power SW version	-	-	99	
S1.3	835	-	Control part software version	-	-	99	
S1.4	836	-	Firmware interface	-	-	99	
S1.5	837	-	Application ID	-	-	99	
S1.6	838	-	Application revision	-	-	99	
S1.7	838	-	System load	-	-	99	
S2.1	808	-	Communication status	RS485 in xx.yyy format xx = Number of error messages (0 - 64) yyy = Number of correct messages (0 - 999)		99	
S2.2	809	-	Error bus protocol	0 = FB disabled 1 = Modbus	0	99	
S2.3	810	-	Slave address	1 – 255	1	99	
S2.4	811	-	Baud rate	0 = 300 1 = 600 2 = 1200 3 = 2400 4 = 4800 5 = 9600		99	
S2.5	812	-	Number of stop bits	0 = 1 1 = 2	1	99	
S2.6	813	-	Parity type	0 = None (inaccessible)	0	99	
S2.7	814	-	Communication timeout	0 = Not used 1 = 1 s 2 = 2 s …	0	99	
S2.8	815	-	Reset communication status	0 = Not used 1 = Resets parameter S2.1	0	100	
S3.1	827	-	MWh counter	MWh	-	100	
S3.2	828	-	Operating days	d	-	100	
S3.3	829	-	Operating hours	h	-	100	
S4.1	830	-	Display contrast	0 - 15	7	100	
S4.2	831	-	Factory setting (WE)	0 = Factory setting or changed value 1 = Restores factory settings for all parameters	0	100	

All Parameters

→ When first switching on or after activating the default settings (S4.2 = 1) parameter P1.1 must be set to 0 for access to all parameters.

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
Parameter selection							
P1.1	115	✓	Parameter ranges	0 = All parameters 1 = Only quick configuration parameters	1	71	
P1.2	540	-	Applications	0 = Basic 1 = Pump drive 2 = Fan drive 3 = Hoisting device (high load)	0	71	
Analog input							
P2.1	379	✓	AI1 Signal range	0 = 0 – 10 V 1 = 2 – 10 V	0	73	
P2.2	380	✓	AI1, minimum value	-100.00 – 100.00 %	0.00	73	
P2.3	381	✓	AI1, maximum value	-100.00 – 100.00 %	100.00	73	
P2.4	378	✓	AI1, filter time constant	0.0 – 10.0 s	0.1	73	
P2.5	390	✓	AI2 Signal range	2 = 0 – 20 mA 3 = 4 – 20 mA	3	73	
P2.6	391	✓	AI2, minimum value	-100.00 – 100.00 %	0.00	73	
P2.7	392	✓	AI2, maximum value	-100.00 – 100.00 %	100.00	73	
P2.8	389	✓	AI2, filter time constant	0.0 – 10.0 s	0.1	73	
Digital input							
P3.1	300	✓	Sart/stop logic	0 = DI1 (FWD), DI2 (REV) and REAF 1 = DI1 + DI2 (= REV) 2 = DI1 (Start pulse), DI2 (Stop pulse) 3 = DI1 (FWD), DI2 (REV)	3	75	
P3.2	403	✓	Start signal 1	0 = Deactivated 1 = DI1 2 = DI2 3 = DI3 4 = DI4 5 = DI5 6 = DI6	1	75	
P3.3	404	✓	Start signal 2	Like P3.2	2	75	
P3.4	412	✓	Reversing	Like P3.2	0	75	
P3.5	405	✓	External fault (High-Signal)	Like P3.2	0	76	
P3.6	406	✓	External fault (Low Signal)	Like P3.2	0	76	
P3.7	414	✓	Error acknowledgment	Like P3.2	5	76	
P3.8	407	✓	Start enable	Like P3.2	0	76	
P3.9	419	✓	Fixed speed B0	Like P3.2	3	76	
P3.10	420	✓	Fixed speed B1	Like P3.2	4	76	
P3.11	421	✓	Fixed speed B2	Like P3.2	0	76	
P3.12	1020	✓	Deactivate PI controller	Like P3.2	6	76	

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
Analog output							
P4.1	307	✓	AO Signal	0 = Deactivated 1 = Output frequency (0 - f_{max}) 2 = Output current (0 - $I_{N\ Motor}$) 3 = Torque (0 - M_N) 4 = PI controller, output	1	78	
P4.2	310	✓	AO, minimum value	0 = 0 mA 1 = 4 mA	1	78	
Digital output							
P5.1	314	✓	RO1 Signal	0 = Not used 1 = Ready to start 2 = Operation (RUN) 3 = fault signal (FAULT) 4 = Error message (inverted) 5 = Warning (ALARM) 6 = Reversing (FWD ↔ REV) 7 = Setpoint reached 8 = Motor controller active	2	79	
P5.2	313	✓	RO2 Signal	Like P5.1	3	79	
P5.3	312	✓	DO1 Signal	Like P5.1	1	79	
Drives control							
P6.1	125	✓	Control level	1 = Control signal terminals (I/O) 2 = Control unit (KEYPAD) 3 = Interface (BUS)	1	80	
P6.2	117	✓	Setpoint input	0 = Fixed frequency (FF0) 1 = Control unit (UP/DOWN) 2 = Interface (BUS) 3 = AI1 (analog setpoint 1) 4 = AI2 (analog setpoint 2)	3	80	
P6.3	101	-	Minimum frequency	0.00 – P6.4 Hz	0.00	81	
P6.4	102	-	Maximum frequency	P6.3 – 320 Hz	50.00	81	
P6.5	103	-	Acceleration time	0.1 – 3000 s	3.0	81	
P6.6	104	-	Deceleration time	0.1 – 3000 s	3.0	81	
P6.7	505	-	Start function	0 = Ramp (acceleration) 1 = Flying restart circuit	0	82	
P6.8	506	-	Stop function	0 = Fee coasting 1 = Ramp (deceleration)	0	82	
P6.9	500	-	Wave form, time-based S-form	0.0 = Linear 0.1 - 10.0 s (S-shaped)	0.0	82	
P6.10	717	-	Waiting time before an automatic restart (→ P6.13 = 1)	0.10 – 10.00 s	0.50	83	
P6.11	718	-	Testing period across three automatic restarts (→ P6.13 = 1)	0.00 – 60.00 s	30.00	83	
P6.12	719	-	Start function with automatic restart	0 = Ramp 1 = Flying restart circuit 2 = according to P6.5	0	83	
P6.13	731	-	Automatic restart	0 = Not enabled 1 = active (→ REAF)	0	83	

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
P6.14	1600	✓	Reference input, operating unit (UP – STOP – DOWN)	0 = Changes the direction of rotation (FWD ⟷ REV) when set value of zero passes through 1= Stops the drive with a set value of zero	1	83	
Motor							
P7.1	113	-	Motor nominal current	0.2 × I_e – 2 × I_e (→ Motor rating plate)	1.1 × I_e	85	
P7.2	107	-	Current limit	0.2 × I_e – 2 × I_e	1.5 × I_e	85	
P7.3	112	-	Motor nominal speed	300 – 20000 rpm (→ Motor rating plate)	1440	85	
P7.4	120	-	Motor power factor (cos φ)	0.30 – 1.00 (→ Motor rating plate)	0.85	85	
P7.5	110	-	Motor nominal voltage	180 – 500 V (→ Motor rating plate)	230 400	85	
P7.6	111	-	Nominal motor frequency	30 – 320 Hz (→ Motor rating plate)	50.00	85	
Protective functions							
P8.1	700	-	Response to 4 mA reference value error	0 = Deactivated 1 = Warning 2 = Error, stop according to P6.8	1	86	
P8.2	727	-	Response to undervoltage error	Like P8.1	2	86	
P8.3	703	-	Earth fault protection	Like P8.1	2	86	
P8.4	709	-	Blocking protection mechanism	Like P8.1	1	86	
P8.5	713	-	Underload protection	Like P8.1	0	87	
P8.6	704	-	Motor temperature protection	Like P8.1	2	87	
P8.7	705	-	Motor ambient temperature	-20 – +100 °C	40	87	
P8.8	706	-	Cooling factor at zero frequency	0.0 – 150 %	40.0	87	
P8.9	707	-	Motor temperature time constant	1 – 200 min	45	87	
PI controller							
P9.1	163	✓	PI controller	0 = Deactivated 1 = to drive control 2 = for external application	0	89	
P9.2	118	✓	PI controller, P amplification	0.0 – 1000 %	100.0	89	
P9.3	119	✓	PI controller, I time constant	0.00 – 320.0 s	10.00	89	
P9.4	167	✓	PI controller, setpoint via control unit	0.0 – 100.0 %	0.0	89	
P9.5	332	✓	PI controller, setpoint source	0 = Control unit 1 = Interface (BUS) 2 = AI1 3 = AI2	0	89	

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
P9.6	334	✓	PI controller, actual value	0 = Deactivated 1 = AI1 2 = AI2	2	90	
P9.7	336	✓	PI controller, actual value limiting, minimum	0.0 – 100.0 %	0.0	90	
P9.8	337	✓	PI controller, actual value limiting, maximum	0.0 - 100.0 %	100.0	90	
P9.9	340	✓	PI controller, invert controller deviation	0 = No inversion (Actual value < setpoint → increase PI output value) 1 = Inversion (Actual value < setpoint → decrease PI output value)	0	90	
Fixed frequency							
P10.1	124	✓	Fixed frequency FF0	0.00 – P6.4 Hz	5.00	92	
P10.2	105	✓	Fixed frequency FF1	0.00 – P6.4 Hz	10.00	92	
P10.3	106	✓	Fixed frequency FF2	0.00 – P6.4 Hz	15.00	92	
P10.4	126	✓	Fixed frequency FF3	0.00 – P6.4 Hz	20.00	92	
P10.5	127	✓	Fixed frequency FF4	0.00 – P6.4 Hz	25.00	92	
P10.6	128	✓	Fixed frequency FF5	0.00 – P6.4 Hz	30.00	92	
P10.7	129	✓	Fixed frequency FF6	0.00 – P6.4 Hz	40.00	92	
P10.8	130	✓	Fixed frequency FF7	0.00 – P6.4 Hz	50.00	92	
V/Hz characteristic							
P11.1	108	-	V/f characteristic curve	0 = Linear 1 = Quadratic 2 = Configurable	0	93	
P11.2	602	-	Cut-off frequency	30.00 – 320.00 Hz	50.00	94	
P11.3	603	-	Output voltage	10.00 – 200.00 % of the motor rated voltage (P6.5)	100.00	94	
P11.4	604	-	V/f characteristic curve, mean frequency value	0.00 – P11.2 [Hz]	50.00	94	
P11.5	605	-	V/f characteristic curve, mean voltage value	0.00 – P11.3 [Hz]	100.00	94	
P11.6	606	-	Output voltage at 0 Hz	0.00 – 40.00 %	0.00	94	
P11.7	109	-	Torque increase	0 = Not enabled 1 = Enabled	0	94	
P11.8	600	-	Motor control mode	0 = Frequency control (V/Hz) 1 = Speed control (sensorless vector)	0	95	
P11.9	601	-	Pulse frequency	1.5 – 16.0 kHz	6.0	95	

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
Braking							
P12.1	507	-	DC braking, current	A, dependent on I_e	I_e	96	
P12.2	516	-	DC braking, braking time at start	0.00 – 600.00 s	0.00	96	
P12.3	515	-	DC braking, start frequency during delay ramp	0.00 – 10.00 Hz	1.50	97	
P12.4	508	-	DC braking, braking time in case of STOP	0.00 – 600.00 s	0.00	98	
(P12.5)	504	-	Brake chopper	(only visible with braking transistor installed) 0 = Deactivated 1 = Active in RUN 2 = in RUN and STOP active	0	98	

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	User setting
System							
Hard- and Software Information							
S1.1	833	-	Software package	-	-	99	
S1.2	834	-	Power section, Software version	-	-	99	
S1.3	835	-	Control part software version	-	-	99	
S1.4	836	-	Firmware interface	-	-	99	
S1.5	837	-	Application ID	-	-	99	
S1.6	838	-	Application revision	-	-	99	
S1.7	839	-	System load	%	-	99	
Communication							
S2.1	808	-	Communication status	Format xx.yyy xx = Number of error messages (0 - 64) yyy = Number of correct messages (0 - 999)		99	
S2.2	809	-	Error bus protocol	0 = field bus deactivated 1 = Modbus	0	99	
S2.3	810	-	Slave address	1 – 255	1	99	
S2.4	811	-	Baud rate	0 = 300 1 = 600 2 = 1200 3 = 2400 4 = 4800 5 = 9600	5	99	
S2.5	812	-	Number of stop bits	0 = 1 stop bit 1 = 2 stop bit	1	99	
S2.6	813	-	Parity type	0 = None (inaccessible)	0	99	
S2.7	814	-	Communication timeout	0 = Not used 1 = 1 s 2 = 2 s … 255 s	0	99	
S2.8	815	-	Reset communication status	0 = Not used 1 = Resets parameter S2.1	0	100	
Unit counter							
S3.1	827	-	MWh counter	MWh	-	100	
S3.2	828	-	Operating days	d	-	100	
S3.3	829	-	Operating hours	h	-	100	
User Set							
S4.1	830	-	Display contrast	0 – 15	7	100	
S4.2	831	-	Factory setting (WE)	0 = Factory setting or changed value 1 = resets to default settings for all parameters	0	100	

PNU	ID	Access right RUN	Designation	Value range	Factory setting	Page	Measured values
Display value							
M1.10	1	-	Output frequency	Hz	0.00	101	
M1.2	25	-	Frequency reference value	Hz	0.0	101	
M1.3	2	-	Motor shaft speed	rpm (calculated value, rpm)	0	101	
M1.4	3	-	Motor current	A	0.00	101	
M1.5	4	-	Motor torque	% (calculated value)	0.0	101	
M1.6	5	-	Motor power	% (calculated value)	0.0	101	
M1.7	6	-	Motor voltage	V	0.0	101	
M1.8	7	-	Intermediate DC voltage circuit	V	000.0	101	
M1.9	8	-	Unit temperature	°C	00	101	
M1.11	13	-	Analog input 1	%	0.0	101	
M1.12	14	-	Analog input 2	%	0.0	101	
M1.13	26	-	Analog output 1	%	0.0	101	
M1.14	15	-	Digital input	DI1, DI2, DI3 status	0	101	
M1.15	16	-	Digital input	DI4, DI5, DI6 status	0	101	
M1.16	17	-	Digital output	RO1, RO2, DO status	1	101	
M1.17	20	-	PI setpoint	%	0.0	101	
M1.18	21	-	PI feedback	%	0.0	101	
M1.19	22	-	PI error value	%	0.0	101	
M1.20	23	-	PI Output	%	0.0	101	

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